CITY OF HAMILTON

Rennie Street Landfill
Remedial Works

Submitted by

Dillon Consulting
Limited

00-7447
August 2000

COPY

DILLON
CONSULTING

1425
Bishop Street
Cambridge
Ontario, Canada
N1R 6J9
Telephone
(519) 623-6761
Fax
(519) 623-8805

August 29, 2000

Power Budd
1 Canadian Place
Suite 7210, P.O. Box 148
Toronto, ON
M5X 1C7

Attention: Mr. David Crocker

Rennie Street Landfill
Report on Remedial Works

Dear Mr. Crocker:

Enclosed is our report outlining the remedial works for the former Rennie Street Landfill in Hamilton. The report includes the results of the environmental investigations on which the requirements for the remedial works are based. The status of the implementation of remedial works is also discussed.

Should you have any questions or require further information, please contact the undersigned.

Yours sincerely,

Dillon Consulting Limited

Patsy Duever

Patsy Duever, M.A.Sc.
Project Manager

copy: Reg Meiers, City of Hamilton
Peter Dunn, Region of Hamilton-Wentworth

00-7447
encl.

TABLE OF CONTENTS

1.0 INTRODUCTION . . . 1
- 1.1 Purpose and Objective . . . 1
- 1.2 Site Description and Background . . . 1
- 1.3 Status of the Remedial Works . . . 2
- 1.4 Organization of the Report . . . 2

2.0 METHODOLOGY . . . 4
- 2.1 Test Pit Excavation . . . 4
- 2.2 Drilling and Monitor Completion . . . 4
  - 2.2.1 Borehole Drilling and Soil Sampling . . . 5
  - 2.2.2 Gas Monitoring Well Installation . . . 5
  - 2.2.3 Groundwater Monitoring Well Installation . . . 6
  - 2.2.4 Groundwater Pumping Test Well Installation . . . 6
- 2.3 Gas Surveying . . . 7
- 2.4 Geophysical Surveying . . . 7
- 2.5 Soil/Waste and Groundwater Sampling . . . 8
- 2.6 Surface Water, Outfall, Bank Soil and Seep Sampling . . . 9

3.0 RESULTS . . . 10
- 3.1 Geology . . . 10
- 3.2 Hydrogeology . . . 12
- 3.3 Limits of Waste . . . 15
- 3.4 Soil, Waste and Groundwater/Leachate Analytical Results . . . 16
  - 3.4.1 Soil Analytical Results . . . 16
  - 3.4.2 Waste and Fill Analytical Results . . . 17
  - 3.4.3 Groundwater Analytical Results . . . 18
- 3.5 Surface Water Analytical Results . . . 21
- 3.6 Outfall Analytical Results . . . 22
- 3.7 Seep Water Analytical Results . . . 23
- 3.8 Creek Bank Soil Analytical Results . . . 23
- 3.9 Landfill Gas . . . 24
- 3.10 Slope Stability . . . 25

4.0 SUMMARY OF CONCLUSIONS . . . 26

5.0 REMEDIAL ACTIONS . . . 29
- 5.1 Interim Controls . . . 29
- 5.2 Alternatives . . . 31
  - 5.2.1 Bank Erosion Alternatives . . . 31
  - 5.2.2 Leachate Seepage Control . . . 35
  - 5.2.3 Buried Utilities . . . 39

5.3 Preferred Solution 42
5.3.1 Control Leachate Generation and Landfill Gas 42
5.3.2 Erosion Control 43
5.3.3 Collect Leachate 43
5.4 Implementation Plan 44
5.5 Public Consultation 44

6.0 LIMITATIONS 47

7.0 REFERENCES 48

LIST OF FIGURES

Figure 1 – Site Location
Figure 2 – Site Plan
Figure 3 – Cross Section A-A'
Figure 4 – Cross Section B-B'
Figure 5 – Cross Section C-C'
Figure 6 – Cross Section D-D'
Figure 7 – Cross Section E-E'
Figure 8 – Limits of Waste in Plan
Figure 9 – Groundwater Elevations
Figure 10 – PCB Concentrations in Leachate
Figure 11 – Chloride Concentrations in Leachate
Figure 12 – Conceptual Design, Local Leachate Collection
Figure 13 – Plan for Widening of Floodplain
Figure 14 – Typical Cross Section of New Creek

LIST OF TABLES

Table 1 – Vertical Gradients
Table 2 – Hydraulic Conductivity Estimates
Table 3 – Summary of Groundwater/Leachate Exceedances
Table 4 – Comparison of Indicator Parameters
Table 5 – Surface Water Impact Analyses
Table 6 – Evaluation of Alternatives
Table 7 – Buried Utilities Remedial Works

LIST OF APPENDICES

Appendix A	–	Test Pit and Borehole Logs
Appendix B	–	Water Levels and Hydraulic Conductivity Testing Data
Appendix C	–	Combustible Gas Monitoring and Heath Consultant's Report
Appendix D	–	Geophysics Reports
Appendix E	–	Summary of Chemical Analytical Data
Appendix F	–	Detailed PCB Sampling and Remedial Investigations at S26
Appendix G	–	Slope Stability Evaluation, Peto MacCallum Ltd.
Appendix H	–	Stream Erosion Assessment, Water Regime and Simulations Ltd.
Appendix I	–	Silt Fence and Boom Inspection/Maintenance Program
Appendix J	–	Display Boards for June 1, 2000 Public Information Session

EXECUTIVE SUMMARY

Dillon Consulting Limited (Dillon) was retained by the City of Hamilton (City) to undertake remedial works at the former Rennie Street Landfill site in Hamilton. The objective of the remedial works is to prevent the discharge of contaminants from the site. This report documents the results of the environmental investigations that have been undertaken to identify where and how waste has been deposited at the site, the types of contaminants present in the waste, and potential migration pathways for these contaminants. Based on the findings from these investigations, requirements for the remedial works were developed, alternatives for these remedial works identified and evaluated, and the preferred option for a cost-effective, long-term solution to prevent the discharge of contaminants from the site selected. The preferred solution and the interim controls that have been implemented until the long-term solution can be implemented.

The Rennie Street Landfill is an old City "dump". It was not registered with the Ministry of the Environment (MOE) as a waste disposal site and therefore little information is available on the quantities and types of wastes that were dumped at the site. Dumping at the site appears to have started in the 1950s and is assumed to have continued until the Public Works Yard was established at the site in the mid 1960s.

The landfill contains approximately 400,000 m^3 of waste and was created by filling in the floodplain of Red Hill Creek. The eastern slope of the landfill forms the west bank of Red Hill Creek. Bank erosion, up to about 0.3 m/year at some locations, is occurring along the landfill slope. Although there is no imminent risk of the slope collapsing, the erosion will at some point in the future lead to bank failure into the creek.

Most of the waste in the landfill is non-hazardous. However, polychlorinated biphenyls (PCBs) have been detected in some samples at concentrations exceeding 50 mg/kg, indicating that some of the waste would be classified as hazardous waste. The highest PCB concentrations appear to be associated with an oily product that floats on the leachate in the landfill. The leachate is being expressed as seeps along the west bank of Red Hill Creek and the PCB-contaminated oil has contaminated the bank soils.

Based on the results of the environmental investigations and an evaluation of alternatives, the recommended remedial actions for the site are:

- control leachate generation by placing a low-permeability cover on the landfill and collecting groundwater before it enters the landfill,
- collect leachate that seeps through the bank in a horizontal collector, and
- prevent erosion by expanding the floodplain and relocating the creek away from the landfill in a naturalized channel.

Due to the magnitude and potential impacts of the remedial works required at the former Rennie Street Landfill and the fact that they are subject to a Federal Environmental Screening under the

Canadian Environmental Assessment Act, these works cannot be completed before the summer of 2001. In the interim, a number of controls are being implemented to minimize discharges to Red Hill Creek until the permanent solution can be implemented. These interim controls include:

- the installation of silt fences and absorbent boom/pads at all identified seeps to prevent discharge of oily product and contaminated soils into the creek,
- daily inspections of the silt fences and absorbent booms/pads and repair as needed,
- daily inspection of the west bank of Red Hill Creek and installation of new silt fences and absorbent booms/pads as new seeps are identified, and
- installation of localized leachate collectors at two of the most severe seepage location along the west bank to collect most of the leachate discharged at these locations. In July and August, approximately 45,000 litres of leachate was intercepted at the collectors and shipped off-site for disposal.

A plan to plug buried storm sewers that discharge to the creek has been developed and will be implemented in the next couple of months, subject to receipt of regulatory approvals. As well, the City is in the process of removing road construction and maintenance materials that are stored on the site so that a low-permeability cover can be placed on the landfill in the next few months.

Action	**Schedule**
Construct localized collectors into the west bank of the creek:	
– at seeps S4-S20 at the south end of the site	June 2000
– at seep S19 at the north end of the site	July 2000
Evaluate the effectiveness of these trenches and extend to other seep areas, if effective	June – October 2000
Confirm the feasibility of installing a groundwater cut-off trench on the west side of the landfill	June – October 2000
Design and install low-permeability cover	June – December 2000
Re-locate buried utilities through Rennie Street Landfill and plug and cut off existing pipes where possible	June – September 2000
If feasible, install temporary erosion protection in creek	June – September 2000
Install passive gas barrier	November – December 2000
Expand floodplain and relocate the creek:	
– complete the design and Environmental Assessment	June – December 2000
– construction	Contingent Upon Approvals

1.0 INTRODUCTION

1.1 Purpose and Objective

Dillon Consulting Limited (Dillon) was retained by the City of Hamilton (City) to undertake remedial works at the former Rennie Street Landfill site in Hamilton. The objective of the remedial works is to prevent the discharge of contaminants from the site. To do this, it is necessary to identify the types of contaminants present at the site, the pathways by which these contaminants may leave the site and to identify ways of eliminating these pathways.

The purpose of this report is to document the results of the environmental investigations that have been undertaken to identify where and how waste has been deposited at the site, the types of contaminants present in the waste, and potential migration pathways for these contaminants. Based on the findings from these investigations, requirements for the remedial works were developed. Options for these remedial works were identified were and evaluated. This report documents this evaluation and describes the preferred option for a cost-effective, long-term solution to prevent the discharge of contaminants from the site.

1.2 Site Description and Background

The former Rennie Street Landfill is currently occupied by the City of Hamilton's Brampton Street Public Works Yard, located at 2200 Brampton Street in the east end of Hamilton. This location is indicated on Figure 1.

Lands surrounding the site have mixed use. Immediately north is the closed Brampton Street Landfill, which is owned and monitored by the Region of Hamilton-Wentworth, and the Region's Woodward Avenue Water and Sewage Treatment Plants. Along the west side of the site are residential properties on Waterloo Street, and industrial properties on Rennie Street. The south end is bounded by a railway line which was constructed in the late 1800s. The landfill is adjacent to Red Hill Creek to the east. Beyond Red Hill Creek, land use is industrial and includes a bus manufacturing facility and automobile scrap yards.

The Public Works Yard has been active at the site since about the mid 1960s. A railway spur, used to transport chlorine to the water treatment plant, extends north-south, approximately through the middle of the site. There are a number of buildings on the west side of the site associated with the Public Works Yard, including a salt dome used to store road salt, a one storey office building and several equipment sheds and maintenance garages. The site is used for vehicle parking and storage of road maintenance materials, such as crushed concrete, street sweepings, etc. These materials are generally stored on the east side of the railway spur.

The Rennie Street Landfill is an old City "dump". It was not registered with the Ministry of the Environment (MOE) as a waste disposal site and therefore little information is available on the quantities and types of wastes that were dumped at the site. Based on a review of historical aerial photographs, dumping at the site appears to have started in the 1950s and is assumed to have continued until the Public Works Yard was established at the site in the mid 1960s.

The landfill is adjacent to the Red Hill Creek and was generally formed by dumping waste into the floodplain of the creek. Based on the reports from local residents and later confirmed by engineering drawings from the City of Hamilton, there were two ravines on the site, to the west of the railway spur, that have been filled in with fill materials and/or waste.

In November of 1999 the Ministry of the Environment (MOE) issued a Field Order to the City requiring that the City identify contaminants in the landfill and how these contaminants are leaving the site. Also under the field order, off-site impacts are to be identified and cleaned up.

1.3 Status of the Remedial Works

Due to the magnitude and potential impacts of the remedial works required at the former Rennie Street Landfill and the fact that they are subject to a Federal Environmental Screening under the Canadian Environmental Assessment Act, these works cannot be completed before the summer of 2001. In the interim, a number of controls are being implemented to minimize discharges to Red Hill Creek until the permanent solution can be implemented. These interim controls include:

- the installation of silt fences and absorbent boom/pads at all identified seeps to prevent discharge of oily product and contaminated soils into the creek,
- daily inspections of the silt fences and absorbent booms/pads and repair as needed,
- daily inspection of the west bank of Red Hill Creek and installation of new silt fences and absorbent booms/pads as new seeps are identified, and
- installation of localized leachate collectors at two of the most severe seepage location along the west bank to collect most of the leachate discharged at these locations.

A plan to plug storm sewers utilities that discharge to the creek has been developed and will be implemented in the next couple of months, subject to receipt of regulatory approvals. As well, the City is in the process of removing road construction and maintenance materials that are stored on the site so that a low-permeability cover can be placed on the landfill in the next few months.

Data collection and assessment for the Federal Environmental Screening is underway. One of the key components of this screening is the need to identify potential adverse environmental effects, propose measures to address the effects and consider whether or not the residual effects are significant.

A conceptual design for the remedial works has been prepared and is described in this report. Detailed design is underway.

1.4 Organization of the Report

The report is presented in seven sections, of which this Introduction is the first. The environmental investigations are described in Sections 2 and 3. A summary of the conclusions of these investigations is presented in Section 4. Section 5 describes the remedial actions that have been

implemented as interim controls, an evaluation of options for long-term solutions, and preferred long-term solution. Section 6 is a discussion on the limitations inherent in investigations of this nature. A listing of reference materials related to the Rennie Street Landfill is included in Section 7.

2.0 METHODOLOGY

The environmental investigations at the Rennie Street Landfill involved six main activities:

- test pit excavation
- drilling of boreholes and installation of monitoring and pumping wells,
- soil and groundwater sampling,
- subsurface gas survey,
- geophysical surveying, and
- surface water, outfall, seep and sediment sampling.

The methodology of each of these activities is discussed below and the results are discussed in Section 3.

2.1 Test Pit Excavation

Thirty-eight (38) test pits were excavated to investigate the Rennie Street Landfill. The test pits were generally located across the western half of the City of Hamilton Public Works yard with the exception of TP3 and TP38, which are located in the south-east and north-east portions of the landfill, respectively. These test pits were excavated to determine the extent of the present waste fill, depth to bedrock and geology in this area and to aid in the interpretation of the geophysical survey (see Section 2.4).

The locations of these test pits (TP1 to TP38, inclusive) are shown on Figure 2 (back pocket). Test pit logs describing the subsurface conditions encountered are included in Appendix A

The depth of the test pits ranged from 0.15 metres below ground surface ("mbgs") at TP6 and TP7 to 4.3 mbgs at TP20, TP28, TP31 and TP36. Test pits TP6 and TP7 were only excavated to a depth of 0.15 mbgs due to the presence of concrete which was interpreted to be a former building foundation. A total of 12 test pits (TP1, TP5, TP8, TP9, TP25, TP27, TP29, TP30, TP32, TP34, TP35, and TP37) were terminated in shale bedrock or at the bedrock surface. All of the remaining test pits were terminated above the bedrock surface.

2.2 Drilling and Monitor Completion

To date, Dillon has completed boreholes at fifty (50) locations within the landfill and another three (3) boreholes were completed off-site on Hamilton Street Pallet Company site at 822 Rennie Street. Boreholes were drilled to determine the vertical extent of the present waste fill, depth to bedrock, geology and hydrogeology in this area, and, to investigate the presence of combustible gases along the western edge of the landfill. The locations of all of these investigative locations are shown on Figure 2. The borehole and groundwater monitor completion details are summarized on Table A-1 in Appendix A. Appendix A also contains borehole logs which include detailed information on stratigraphy and monitoring well installation.

Seven (7) boreholes were completed as gas monitoring wells (GW1 to GW7, inclusive). Twenty-nine (29) were completed as groundwater monitoring wells (designated as "MW"). One borehole (PW6-1) was completed as a pumping well (designated as "PW"). The remaining thirteen (13) boreholes ("BH" series) were backfilled with drill cuttings and a surface seal of bentonite (an expanding clay product). Five of the on-site monitoring locations were completed as multi-level installations with monitoring wells at different horizons, these are indicated by an "A" or "B" suffix on the monitoring well designation. The "A" suffix (e.g. MW6-49A) indicates the upper horizon that is monitored and conversely the "B" suffix (e.g. MW6-49B) indicates the lower horizon. The "A" and "B" monitoring wells in each monitoring pair were completed in adjacent boreholes.

2.2.1 Borehole Drilling and Soil Sampling

The boreholes were completed between September 22, 1997 and July 11, 2000, as part of several different investigations. The majority were drilled by Atcost Soil Drilling Inc. using a truck mounted CME 75 drill rig and 22 cm diameter hollow stem augers. Atcost Soil Drilling Inc. also completed the pumping well (PW6-1) using the CME 75 drill rig and 26 cm diameter hollow stem augers. Selected boreholes (MW6-51A/B to MW6-57, MW6-63 to MW6-65 and GW-7, inclusive) were completed by Sonic Soil Sampling using a Pionjar 120 system percussion method due to access problems.

All soil sampling was performed using the split spoon method, except for PW6-1 and GW1 to GW6, inclusive. PW6-1 and the six gas monitoring wells were logged by observing the drill cuttings. The split spoon method allowed a 0.04 m diameter, soil core to be obtained at different depth intervals in each borehole. The split spoon sampler was advanced through undisturbed material for either 0.6 m per sampling run or to spoon refusal. The split spoon sampler was then withdrawn and the sample recovered. Soil samples were logged on-site for texture, colour, grain size, presence of fractures and visual or olfactory signs of contamination.

At MW6-49B and MW5-58B, the hollow stem augering technique was used until refusal was reached (depths of 5.9 and 4.6 mbgs, respectively) below this depth rock coring methods were used. The rock core was logged on-site for texture, colour, presence of fractures and visual or olfactory signs of contamination.

The soil and rock sampling equipment was washed in detergent and rinsed in tap water between each sampling run. The augers and all sampling equipment were washed using a high pressure washer with tap water following completion of each borehole.

Where no monitoring well was installed, drill cuttings were used to backfill the borehole to about 0.5 m below grade and sealed at the surface with bentonite pellets.

2.2.2 Gas Monitoring Well Installation

Gas monitoring wells were installed in boreholes GW1 to GW7, inclusive. Upon completion of these boreholes a flush threaded PVC riser pipe connected to10 slot, PVC screen was run into the hole. The screen lengths are shown on Table A-1, Appendix A. Washed No. 3 silica sand was poured

around the screen to form a filter pack and a bentonite seal was placed just above the filter pack to just below grade. The monitoring wells had either flush mounted steel casings or above ground steel casings installed for protection.

As previously mentioned, the gas monitoring wells (GW-1 to GW-6, inclusive) were logged from observing the drill cuttings. It is possible that the use of this logging technique at these locations may have resulted in the strata not being accurate (e.g. the difference in the reported logs from GW-6 and TP16). This problem is due to the difficulty in differentiating materials from drill cuttings.

2.2.3 Groundwater Monitoring Well Installation

Groundwater monitoring wells were installed in the "MW" series of boreholes. Upon completion of a borehole by augering, Schedule 40 flush threaded PVC riser pipe was run into the hole with a length of No. 10 slot PVC screen. The length of the screen varied from 1.52 to 3.05 m. A washed No. 3 silica sand was placed around the screen to form a filter pack, followed by bentonite gravel holeplug to form a seal from above the filter pack. The monitoring wells had either flush mounted steel casings or above ground steel casings installed for protection. For monitoring wells completed using the Pionjar 120 system, sand pack and/or seal was not always possible due to slumping.

Measurements of the static water level in these monitoring wells were collected to determine the direction of groundwater flow. Water level measurements were made using an electric water level meter. Water level measurements were taken at several times during the investigations. The latest complete round of water levels were measured on July 19, 2000. At that time, an interface probe was used to estimate the thickness of any light non-aqueous phase product ("LNAPL") or oily product on top of the water table. Water levels are summarized in Appendix B.

Single well (slug) testing was conducted on selected monitoring wells between October 13, 1998 and May 25, 2000. These tests generally involved adding a known volume of water to the well and monitoring the change in the water level with time as it recovered to its pre-testing (static) level. The water level data and analyses from these tests are included as part of Appendix B.

2.2.4 Groundwater Pumping Test Well Installation

The pumping test well, PW6-1, was completed using a slightly different technique from what was followed for the monitoring wells. As previously indicated, the borehole for the pumping well was drilled using 26 cm diameter hollow stem augers. Upon completion of this borehole, a 15.2 cm diameter, Schedule 40 flush threaded PVC riser pipe connected to a 6.1 metre long No. 10 slot PVC screen was installed in the borehole. A washed silica sand was placed around the screen to form a filter pack. A bentonite gravel holeplug seal was placed above the filter pack, the hole was then backfilled with drill cuttings to near surface. The well was finished with an above ground steel casing for protection.

Pumping tests were conducted on this well during October 1999. The pumping test data and analyses are included as part of Appendix B.

2.3 Gas Surveying

Combustible gas measurements were taken from the soil gas monitors on five occasions (October 13, 1998, November 12, 1998, December 2, 1998, January 26, 1999, February 12, 1999 and July 19, 2000). A combustible gas meter, calibrated to methane, was used for these measurements. At low concentrations, measurements were recorded as either a percentage of the lower explosive limit (% LEL) or for higher concentrations as the per cent gas by volume (% gas). The lower explosive limit for methane is 5% gas by volume (i.e., 100% LEL = 5% gas). The results of the combustible gas monitoring are summarized in Appendix C.

Combustible gas measurements were also completed in the three on-site buildings within the Public Works Yard on three occasions: December 2, 1998, January 26, 1999 and February 12, 1999. A combustible gas survey of the homes bordering on the Rennie Street Landfill was also completed on December 14-18, 1998. The results of these measurements are included in Appendix C.

Heath Consultants was retained to complete an assessment of the likely source of combustible gas detected in the subsurface underneath the Public Works Yard. This involved the collection of gas samples from two soil gas wells (GW3 and GW6), from a leachate well (MW6-44) (to provide a reference sample for landfill gas at the site) and from the Union Gas meter (to provide a reference sample of natural gas). Laboratory analysis of the gas samples was subsequently completed by gas chromatography.

Heath Consultants also completed an assessment of subsurface gas along the western property boundary of the Works Yard. A 40-inch plunger bar and a GMI Gasurveyor 4 Combustible Gas Indicator were used in this assessment. Test holes were placed at three to four metre intervals along the west fence line adjacent to properties on Waterloo Street. Test holes were also placed at suspect vegetation locations along the west paving line of the property and at random locations of the grassed area.

Interior inspections were also conducted at any potential penetration points in the foundations (e.g. any cracks or conduit entrance points) of three on-site buildings using a Heath D.P.II flame ionization detector. The Heath Consultants report is also included in Appendix C.

2.4 Geophysical Surveying

As part of the determination of the present limits of the present waste fill area, two geophysical surveys were conducted. For the first survey, Dillon retained Hyd-Eng Geophysics Incorporated (Hyd-Eng) to perform a surface geophysical of the northern portion of the Public Works Yard. The second geophysical survey was conducted by Dillon over the remaining southern portion of the Rennie Street Landfill. Both of these reports are included as Appendix D.

Both geophysical surveys utilized a GEONICS EM-31. The EM-31 is a electromagnetic instrument which is used to measure the changes in the electrical conductivity of the near surface materials. Changes in the electrical conductivity of these near surface materials are used to imply changes in the either the natural materials and/or the presence of waste. Typically, landfill waste and the associated

leachate have significantly higher conductivities allowing for their delineation based on their electrical conductivity. Hyd-Eng used existing data from boreholes and test pits to determine representative electrical conductivities of the various units in the survey area.

Hyd-Eng's survey utilized the EM-31 in conjunction with a Trimble Global Positioning System (GPS). The GPS system allows for the real time measurements of the location of a point. When the GPS system is used in conjunction with the EM-31 instrument it allows for the locations of the electromagnetic survey to be accurately plotted and identified contacts to be mapped across the survey area. The GPS system was not required for the second survey since the size and shape of the investigated area allowed for accurate plotting of the survey results.

2.5 Soil/Waste and Groundwater Sampling

Soil/waste and groundwater samples were collected from selected boreholes and groundwater monitoring wells. Soil/waste samples were obtained from boreholes at the intervals indicated on the borehole logs (Appendix A). These included samples of the overlying fill, the refuse contained in the Rennie Street Landfill and native materials. Selected soil/waste samples were submitted for laboratory analysis. Initial sampling was analyzed by Fine Analysis Laboratories Limited of Hamilton. Subsequent samples were analyzed by Philip Analytical Services of London. The results of these analyses are included in Appendix E.

Groundwater samples were obtained from all of the monitoring wells installed during this study which had sufficient water at the time of the scheduled sampling. Groundwater sample was also collected from the one existing monitoring well (W101) that was previously installed by Golder Associates in 1989.

Groundwater samples were collected following development and purging of each of the monitoring wells. The purpose of well development was to remove remnant drilling effects and enhance the hydraulic connection between the well and the geologic formation in which it was installed. The purpose of purging was to ensure that water collected from a monitoring well was representative of ground water resident in that geologic formation and, hence, appropriate for chemical analysis. Development and purging consisted of manually pumping water from the well using a dedicated Waterra inertial pump.

Well development and purging both involved the removal of a target volume of water from a well. This target is related to a "well volume", which represents the volume of water filling the screen and riser pipe when static water level was measured. A target of five well volumes was set for well development and purging since it prescribed the removal of a significant volume of water while remaining within the timeframe of the study. Sampling of groundwater was generally conducted using dedicated Waterra inertial pump system.

Most of the groundwater sampling conducted to date were collected soon after the installation of the monitoring well. Although well development and purging were performed, some of these monitoring wells may not be yielding “representative” water quality within the timeframe of the study. In some cases (e.g. MW6-51A/B, MW6-52A/B and MW6-53A/B) poor response of these monitoring wells

did not allow for complete well development and purging prior to sampling.

A summary of the groundwater samples collected is included in Appendix E.

2.6 Surface Water, Outfall, Bank Soil and Seep Sampling

Surface water, outfall, seep and bank soil sampling was conducted between October 13, 1998 and May 18, 2000. Surface water samples were taken from Red Hill Creek at two locations (shown on Figure 2), upstream of the Rennie Street Landfill at the railroad bridge (SW1) and downstream at the Brampton Street footbridge (SW5). The analytical results from this sampling are included in Appendix E.

In addition to this surface water sampling, seepage meters (SP-1, SP-2 and SP-3) were temporarily established in the sediment of the creek on May 18, 2000. Seepage meters allow for groundwater flow through the sediments to be measured and sampling, if sufficient quantities of water are available. The flow at SP-2 was sampled and the results of these analyses are included in Appendix E.

Five storm sewers (P1, P2, P3, P4 and P9) that have been identified to outfall or discharge in and around Rennie Street Landfill have been sampled. These are the only outfalls that have been observed to flow on a regular basis. Outfall sampling was conducted between October 1998 and May 2000. Initial samples from P3 and P4 were collected from depressions near storm sewer outfalls to replicate sampling conducted by the MOE. P2, P3 and P9 were sampled in May 2000 at which time no flow was observed at P1 or P7. The sample that was collected the outfall at P9 was collected at SW6 and therefore this sample contains both storm sewer effluent and water from a small tributary that comes from Brampton Street Landfill. The analytical results from this sampling are included in Appendix E.

Seep water samples were collected from ten selected seeps in May 2000. These samples were collected by excavating a small depression as close as possible to the seep and waiting for it top fill with water. The sampled seeps were selected to represent "worst case" conditions and/or areas of higher flow. These samples were not filtered and therefore they would be expected to contain particulate matter that may be expected to positively bias (i.e. produce a higher result) the analytical results. The analytical results from this sampling are included in Appendix E.

3.0 RESULTS

3.1 Geology

The study area is located in the Iroquois Plain physiographic region as defined by Chapman and Putnam (1984). The Iroquois Plain physiographic region consists primarily of the lowlands bordering Lake Ontario. The sediments in this physiographic region were deposited as the last glaciers receded and the area was inundated by the former Lake Iroquois. Reportedly, Halton Till is exposed at surface in this area (Freenstra, 1975). The Halton Till is generally reddish-brown, clayey silt to clay till that in this area was later undulated by Lake Iroquois. Lacustrine or lake sediments that are associated with Lake Iroquois are exposed at surface to the north of the study area. In the Red Hill Creek valley these sediments have been eroded away and stream deposits including clay, silt with some sand and gravel have been deposited.

Boreholes drilled in the Rennie Street Landfill generally revealed a stratigraphy consisting of a relatively thin layer of recent fill material, overlying either refuse/waste or silty clay till. These units are in turn underlain by shale bedrock. Geological cross-sections are shown on Figure 3 to 7, inclusive, and the locations of these cross sections are shown on Figure 2. Each of these units are discussed in greater detail below.

The fill unit is generally the uppermost unit in the area of the Public Works Yard with the approximate western limit of fill near the western property boundary, but it is absent at TP30, MW6-36 and MW6-64 and only 0.5 metres of fill present at MW6-65 (Figure 2). Fill is also absent along the creek at MW6-51, MW6-52 and MW6-53 and MW6-57. At one location (MW6-25) fill was also observed to be present within the refuse/waste. The surficial fill unit was found to vary in composition from a brown silty clay with some gravel to a brown poorly sorted, sand and gravel but generally it was a silty sand and gravel. At several locations the composition of this unit consisted of a brown sandy material which is consistent with street sweepings. Occasional concrete, asphalt, brick, possible slag and other debris were encountered throughout this unit during the drilling of these boreholes and is visible on the eastern bank of the landfill. At TP2, a 2.3 m thick layer of clay fill was observed to contain debris and also a 0.05 m thickness of salt which is believed to be associated with the present salt storage in this area. The fill unit is generally less than 2 metres in thickness except along eastern edge where a fill berm increases the thickness of this unit up to 6.0 metres at MW6-48. This unit generally does not have a discernible odour except at BH6-14 where a trace unknown odour was detected.

The refuse/waste material is black, moist-saturated sand/silts/gravels and is highly odouriferous. It contains debris such as wood, glass, plastic, concrete, metal and paper. The majority of the refuse/waste material observed in the boreholes is consistent with a landfill containing domestic waste. There are verbal reports from local residents and indications that along the former north-south ravine (under the Public Works Yard) some industrial waste was disposed at this site (TP28, TP29, and TP31 to TP34, inclusive). The refuse/waste material ranged in thickness up to 11.3 m at MW6-44. The extent of the waste in plan view is shown on Figure 8 and profiles of its distribution are shown on the cross sections (Figures 3 to 7). Historical data indicates that the eastern portion of the site includes the former creek valley and that the original ground surface was at approximately 84

masl in the western portion of the site and that it dropped down to the valley floor at approximately 76 masl just west of MW6-12 (the old cliff is also shown on Figure 8). The majority of the waste is contained within the former creek valley leaving the present creek as a small valley along the eastern edge of the former valley. In addition to the waste in the former creek valley, historical maps also indicate that there were two smaller ravines under the western portion of the site (Figure 8). The larger ravine ran north - south parallel to Waterloo Street within the Public Words Yard. This ravine appears to have been shallower near Rennie Street and deepened as it approaches Brampton Street where it attained a maximum depth of approximately 5 metres. The second ravine ran approximately east - west just north of Rennie Street, the maximum depth of this ravine appears to have been approximately 3 metres. The north-south ravine has been found to contain refuse/waste and fill but only fill has been observed at the southern end of this ravine and the eastern end of the east-west ravine.

The silty clay unit that is underlying the refuse/waste is typically reddish brown, moist to saturated, and contains some gravel. The silty clay unit is variable in thickness across the area ranging in thickness from absent in one location in the north-south ravine (BH6-59) to 4.7 m (MW6-11). The silty clay is believed to represent native material probably resulting from weathering of the underlying Queenston Shale formation. In all of the boreholes except MW6-23 and MW6-59, the silty clay unit rests directly on shale bedrock. At MW6-23 there is a 0.6 m thick gravel unit between the silty clay and bedrock units. At MW6-59 where this silty clay unit is absent, the waste was observed to lie directly on the bedrock surface.

The uppermost bedrock unit underlying the site is generally reported to consist of upper Ordovician Queenston Formation shale (OGS, 1991). The Queenston Formation is widespread in the area, and outcrops principally along the base of the Niagara Escarpment. Twenty-three boreholes (MW6-11, MW6-12, MW6-13, BH6-14, MW6-21, MW6-22, MW6-23, MW6-49, MW6-51, MW6-52, MW6-53, MW6-57, MW6-58, MW6-59, MW6-60, MW6-63, MW6-64, MW6-65, PM-BH1, PM-BH2, PM-BH3, PM-BH4 and W101) and twelve test pits (TP2, TP5, TP8, TP9, TP25, TP27, TP29, TP30, TP32, TP34, TP35 and TP37) completed on site encountered bedrock. This shale is brick-red in colour, thinly bedded, argillaceous shale. The upper portion of this shale was generally observed to be very weathered and generally consist of silty sand sized particles with some clay and gravel. This weathered portion was observed to vary from about 1.1 m (MW6-52 and MW6-58) to 2.8 m (MW6-49) thick and grade into the more competent shale, below. At two locations (W101 and TP5) a thin bed of limestone was reported near the top of the shale.

The elevation of the top of the weathered shale is believed to vary from approximately 67 masl (PM-BH3) to about 83 masl (MW6-65 and GW-2). To date, the elevation of top of the shale under the western portion of the site under the Public Works Yard has been found to vary from about 78.5 masl (MW6-59) in a former ravine to about 83 masl (MW6-65). The elevation of the top of the shale decreases rapidly in the area of the former cliff face (Figures 4, 5, 6 and 7) to between 67 – 71 masl.

3.2 Hydrogeology

Groundwater levels were measured on several occasions to establish groundwater flow directions. Water levels were collected between September 25, 1997 and July 19, 2000. Water level data are summarized in Appendix B. Figure 9 illustrates water level contours based on water levels recorded on July 19, 2000. Generally, the main horizontal groundwater flow direction in the shallow water table aquifer across the site is towards the Red Hill Creek in the overburden and waste. There are two areas in the overburden/waste groundwater flow system where there might be some variation in this general groundwater flow pattern:

- adjacent to the 2.3 metre (90-inch) watermain that runs adjacent to the western property boundary, where shallow groundwater flow is towards this watermain, and,

- in the northern portion of the site the north-south ravine appears to divert some shallow groundwater flow to the north.

There is also one anomaly in the groundwater contours that was not shown on Figure 9, which is a groundwater low centred on MW6-44 (not contoured). The groundwater water level at MW6-44 is 2.3 metres lower than the groundwater level at PW6-1. These wells are separated by only 8.3 metres and both wells are open across similar intervals (waste). The exact cause of this groundwater low is not known but it may be due to the influence of the buried services (storm sewers and a water main) in this area, or, the complex stratigraphy and layering in the waste material.

It should also be noted that during the spring and summer of 2000 that there have been several leaks in the water supply pipes to the Public Works Yard. These leaks were in the on-site water supply piping that ran under the access road near the office (near GW-4). They were fixed just prior to the July 19, 2000 water level monitoring event. They may have been responsible for the observed groundwater high at GW-4 (Figure 9).

Generally, groundwater/leachate elevations in the landfill east of the railroad siding are between 78 and 80 masl (metres above sea level) and the elevation of Red Hill Creek is approximately 75 masl. The horizontal hydraulic gradients range from 0.01 across the former Rennie Street Landfill steepening to almost 0.2 near the creek.

The horizontal groundwater flow direction in the shallow bedrock groundwater flow system across the site is also generally towards the Red Hill Creek. In the shallow bedrock aquifer the horizontal groundwater flow direction would be influenced by the direction and interconnection of any fracturing that is present.

As previously indicated, there are seven functioning multi-level well installations on-site. Table 1 indicates the vertical gradients at these locations that have been calculated between the midpoints of the screened intervals of these wells.

Table 1: Calculated Vertical Gradients

Location	Upper Screened Interval	Lower Screened Interval	Vertical Gradients **1	
			May 15, 2000	July 19, 2000
MW6-49	weathered shale	shale	– 1.08	– 1.00
MW6-51	silty sand & silty clay	weathered shale	– 0.03	– 0.01
MW6-52	clay	weathered shale	– 0.15 **2	– 0.06
MW6-53	silty sand & silty clay	weathered shale	0.08 **2	– 0.04
MW6-58	sandy silt	shale	Not constructed	– 0.17
PM-BH2	waste	silty clay	– 0.76	– 0.42
PM-BH3	waste	weathered shale	– 0.54	– 0.52
PH-BH4	waste	weathered shale	– 0.42	– 0.45

Note **1 – Positive numbers indicates an upward flow. Gradients are calculated by dividing the difference in the water levels at the two monitoring wells at this location by the distance between mid-points in these two wells.

**2 – The water levels collected on this date from these locations are not believed to represent static or equilibrium conditions

Table 1 indicates that vertical groundwater flow within the landfill and to the west (at MW6-49 and MW6-58) is downward through the waste. Along the creek, the shallow groundwater levels are very similar to the creek levels but vertical groundwater flow gradients in the shallow subsurface is generally downward from the overburden into the weathered shale except on May 15, 2000 at MW6-52 where these gradients are apparently reversed. Appendix B and Table 1 indicate that the water level in MW6-52A on this occasion was anomalously low. This is probably due to the low hydraulic conductivity of the clay material in this area ($< 1 \times 10^{-8}$ cm/sec) and the fact that this monitoring well had recently been completed, developed, purged and sampled and as a result did not have sufficient time to recovery to static conditions.

The water level data collected on May 27, 2000 and July 19, 2000 (Appendix B) indicates that the shallow groundwater elevations at MW6-51A, MW6-52A and MW6-53A were similar to but generally slightly higher than the creek level, suggesting that the shallow groundwater would tend to flow into the creek.

Three seepage meters (SP-1, SP-2 and SP-3) were installed in the sediment in the creek on May 18, 2000. Groundwater was observed to be entering two of these seepage meters (SP-1 and SP-2), but no flow was observed into SP-3. The observed flows at SP-1 and SP-2 were approximately 0.01 L/hr and 0.04 L/hr, respectively. The water flowing into SP-2 was sampled (Section 3.4.3).

Hydraulic conductivity testing has been performed at several locations across the site. The data from these tests are included in Appendix B and are summarized on Table 2.

Table 2: Hydraulic Conductivity Estimates

Location	Screened Interval	Test Method	Analysis Method	Result (cm/sec)
PW6-1	Waste	12-hour pumping test, early time 12 hour pumping test, late time 12 hour test, recovery data	Neuman Neuman Theis - Jacob	4.5×10^{-4} 2.2×10^{-4} 1.7×10^{-4}
MW6-12	Waste	Slug Test	Hvorslev	1.3×10^{-4}
MW6-13	Waste	Slug Test	Hvorslev	3.7×10^{-3}
MW6-43	Waste	Slug Test	Hvorslev	3.7×10^{-3}
MW6-44	Waste	Slug Test	Hvorslev	1.3×10^{-3}
MW6-49A	Weathered Shale	Slug Test	Bouwer-Rice	7.0×10^{-6}
MW6-49B	Bedrock	Slug Test	Hvorslev	2.4×10^{-6}
MW6-50	Silty Till	Slug Test	Bouwer-Rice	1.3×10^{-5}
MW6-51A	Silty Sand /Silty Clay	Slug Test	Bouwer-Rice	6.7×10^{-7}
MW6-52A	Clay	Slug Test	Bouwer-Rice	$< 1.0 \times 10^{-8}$ **1
MW6-52B	Weathered Shale	Slug Test	Hvorslev	6.8×10^{-4}
MW6-53A	Silty Sand /Silty Clay	Slug Test	Bouwer-Rice	4.4×10^{-6}
MW6-53B	Weathered Shale	Slug Test	Hvorslev	9.8×10^{-5}

Notes: **1 - There was no observed recovery in the water level in this monitor during the 3.5 hour test duration.

Observations made during the drilling of these boreholes through the waste suggest that groundwater/leachate appears to be ponding on top of the underlying clayey silt/silty clay layer. This would be due to the low hydraulic conductivity of the underlying material. This would be expected since the conductivity contrast between the waste and the silty clay unit is greater than two orders of magnitude. Groundwater levels suggest that there is between 3 m (BH6-21) to 7 m (BH6-43) of leachate ponded on top of the clayey silt unit. This variation in the amount of leachate ponded above the silty clay is likely due to the variability of the waste/refuse, the influence of the creek and the influence of several underground services that exist at the site.

In summary, groundwater mainly enters the landfill through the infiltration of rainfall through the permeable fill cover with a much lesser amount flowing onto the site from the west. This groundwater predominately moves towards the east and becomes impacted by the waste in the landfill. This leachate-impacted groundwater then moves down through the waste until it encounters

the silty clay layer under the waste. Most of the groundwater then flows, along the top of this silty clay unit, easterly towards the creek eventually breaking out along the creek bank as seeps or flowing into the creek in the shallow subsurface. Some groundwater moves through the silty clay and/or through "windows" in this retarding layer (i.e. man-made holes such as along the watermain under the Red Hill Creek and potentially natural "windows" in this unit). Along the creek, the groundwater that is in the shallow overburden would flow to both the creek and into the deeper bedrock (shale) flow system. The groundwater in the shale would continue to flow in the bedrock eventually discharging into Lake Ontario.

3.3 Limits of Waste

The present area of waste was determined using information from the geophysics survey, test pits and boreholes. The estimated limits of waste are shown on Figure 8. Figure 8 indicates that there appear to be two areas of waste; the main area of landfilling and the north-south ravine. The main area of waste is east of the railroad spur and is coincident to the former top of bank (also shown on Figure 8). The waste in the main area of the landfill resulted from the filling of the former creek valley. This method of placement has resulted in the main thickness of waste being near the Red Hill Creek (i.e., east of the railway spur). Along the western edge of the main area of waste, the present surface is relatively flat and the waste pinches out. Along this edge, the observed waste generally has an overlying layer of fill which contains less putrescible debris such as wire, rubber, wood and concrete.

Figure 8 shows that the southern limit of the main area of waste/refuse materials is near the CN embankment, near BH6-54 and BH6-55. It should be noted at this time that the CN railroad line that forms the southern limit of the site and its construction predates the emplacement of the waste at this site. The thickness of the waste in the main area near the southern limit quickly increases so that at monitoring well W101 there was three metres of waste (containing trace metals, plastic and glass) and at MW6-11, there were over 7 m of waste encountered. The eastern limit of the waste in the landfill area is adjacent to Red Hill Creek, this limit is very obvious due to the steep man-made bank along the creek. This steep bank is covered with fill containing concrete, asphalt and brick material along with soil and boulders. Based on the results of the geophysical survey, the northern limit of the main area of waste might be south of the Brampton Street right-of-way. Although at borehole BH6-56 almost two metres of waste was encountered before the borehole had to be terminated due to refusal (drilling technique could proceed any further). Along the southern portion of the western limit of waste the limit of waste extends off-site onto the eastern edge of the Hamilton Street Pallet Company site. Drilling at MW6-61 encountered approximately 3.8 metre of waste, starting at a depth of 2.3 metres below ground surface, but at MW6-60 no waste was encountered. GW-7 which is located in a small swale adjacent to the property line also encountered 1 metre of waste.

The southern limit of waste in the ravine is on the Public Works Yard near Rennie Street. The eastern and western boundaries of this waste are believed to be along the former sides of this ravine, which is shown as the shaded are on Figure 8. The northern limit of waste in the ravine was not encountered and it may well extend into the Brampton Street Landfill to the north.

3.4 Soil, Waste and Groundwater/Leachate Analytical Results

Samples of soil (fill and underlying soil), waste/refuse and groundwater/leachate were collected for chemical analyses. These results are summarized in Appendix F and are discussed in the following subsections.

Analytical results from soil samples have been compared to the Ministry of the Environment (MOE) "Guideline for Use at Contaminated Sites in Ontario" (revised Feb. 1997) criteria for coarse-grained surface soils in a non-potable water condition (hereafter referred to as "Table B soil criteria" or "Table B soil criterion"). These soil samples are generally discussed in terms of the industrial/commercial land use criteria although the residential/parkland criteria are often mentioned. The waste/refuse samples are not considered to be soil and therefore the chemical concentrations were not compared to MOE's Table B soil criteria.

Analytical results for groundwater/leachate samples were compared to the "Guideline for Use at Contaminated Sites in Ontario" (revised Feb. 1997) criteria for non-potable groundwater (hereafter referred to as the "Table B groundwater criteria" or "Table B groundwater criterion"). Groundwater/leachate analysis from monitoring wells installed in the refuse and surrounding areas were also compared to the Regional Municipality of Hamilton-Wentworth Sewer Use By-Law criteria for potential discharge of collected leachate to the Woodward Avenue Wastewater Treatment Plant.

The analytical results from samples of surface water, storm sewer discharges (outfalls) and the water from the seeps have been compared to the MOE's "Water Management: Policies, Guidelines, Provincial Water Quality Guidelines, last revised in July 1994 (hereafter referred to as the "PWQOs").

3.4.1 Soil Analytical Results

Soil samples were taken from the native soils directly underlying the refuse material from boreholes MW6-11 (depth of 10.9m) and MW6-13 (depth of 12.7 m) and from MW6-60 (1.5 - 2.1 m), MW6-63 (0.1-0.6m) and MW6-64 (0.1-0.6m). These samples were analyzed for metals and general parameters (nitrogen, pH, conductivity, and sodium adsorption ratio - SAR) and PAHs. The samples from MW6-60, MW6-63 and MW6-64 were also analyzed for VOCs. The results are summarized in Tables E-1, E-2 and E-3 in Appendix E. Comparison of the analytical results summarized on Tables E-1, E-2 and E-3 with criteria for a Table B soil criteria indicated that there were no parameters present in concentrations exceeding these criteria except for zinc. The zinc concentration in the sample from MW6-63 (0.1 to 0.6 m) was 1050 μg/g and the industrial/commercial criteria is 600 μg/g. These results indicate that the native soils have not been significantly impacted by the landfilled waste.

Soil samples were also collected of the native soil directly underlying waste at boreholes MW6-15, BH6-16, BH6-17, BH6-18, and BH6-19 where high polychlorinated biphenyls (PCBs) concentrations were found in the overlying waste samples. These soil samples and soil samples from the native materials at MW6-60, MW6-63 and MW6-64 were submitted for analyses of PCBs. The PCB results from these samples are summarized in Table E-4 in Appendix E. Except for the sample taken

from BH6-18, all PCB concentrations were less than the Table B soil criteria for industrial/commercial land use of 25 mg/kg. At BH6-18, the concentration of PCBs in the native soil under the waste was 7.48 mg/kg which exceeds the Table B soil criterion for residential/parkland land use of 5.0 mg/kg but as previously indicated it is well below the industrial/commercial land use criterion of 25 mg/kg.

These results suggest that the native soils underlying the waste have not been significantly impacted by the on-site waste.

3.4.2 Waste and Fill Analytical Results

Samples of the waste and fill material encountered in boreholes and test pits were collected for chemical analysis. Waste samples from thirteen locations and fill samples from five locations were submitted for analyses of one or more of the following parameters; general and inorganic parameters, PAHs, VOCs and TPH, and, PCBs. The results of the analyses for inorganic parameters, and PAHs are summarized in Tables E-5 and E-6, in Appendix E, respectively. Waste and fill samples for VOCs and TPH analyses are submitted on Table E-7 and the analytical results are on Table E-8 (Appendix E). Table E-9 in Appendix E summarizes the results from waste classification analyses (Ontario Regulation 347) that were performed on four waste samples.

All of the analytical results (Tables E-5 to Table E-8, inclusive) from the fill samples were less than Table B industrial/commercial criteria except for copper (MW6-62), lead (MW6-62) and zinc (MW6-62, TP 35, aand TP 34). The reported copper and lead concentrations in this sample at MW6-62 from a depth of 0.76 - 1.37 m were 82,400 mg/kg and 28,400 mg/kg, respectively. These results are much higher than the Table B industrial/commercial criterion for copper and lead of 225 mg/kg and 1,000 mg/kg, respectively. These results are thought to be due to the presence of these metals in the fill location.

Tables E-5 and E-6 indicate that in the waste samples the concentrations of boron, lead and zinc were elevated. The reported zinc concentrations in these waste samples ranged up to 7560 mg/kg. The highest zinc concentration was reported in the sample from TP27, which is situated in the former north-south ravine, under the Public Works Yard.

Table E-6 also shows that only low concentrations of some PAHs were detected in these waste and fill samples, generally just slightly above the method detection limit, but well below the Table B soil criteria for either type of land use.

The TPH concentrations (Table E-7) were measured in four waste samples (MW6-59 (two samples), TP27 and TP36), all from the former north-south ravine. All of the TPH results from these waste samples were elevated.

Table E-8 indicates that the reported concentration of PCBs in the waste samples is very variable ranging from less than the method detection limit (<0.01 mg/kg) to over 600 mg/kg. Six samples had PCB concentrations that exceeded the Table B industrial/commercial land use cleanup criterion of 25 mg/kg (BH6-14, MW6-14a, MW6-18 [2 samples], MW6-24 and MW6-42). However, in three

samples (MW6-14 from 7.6-9.8 mbgs, MW6-18 from 6-7.5 mbgs and MW6-18 from 7.6-9.1 mbgs) the concentration exceeded 50 mg/kg indicating that the waste would be classified as PCB containing hazardous waste, as defined under Ontario Regulation 347.

Four samples were extracted in accordance with the Regulation 347 leachate extraction procedure and were analyzed for the metals included in Schedule 4 of this regulation. The analytical results, summarized in Table E-9 indicate that the waste is not hazardous, under Regulation 347. However, as noted above, the analytical samples from MW6-14 and MW6-18 some of the material at these locations would be classified as hazardous waste, based on the PCB concentration.

Based on analytical results received to date some general statements can be made about the distribution of PCBs in the waste. Concentrations of PCB in the lower 5 m of waste are overall higher than those in the upper 5 m. The PCBs are often associated with a weathered diesel/oily product that floats on top of the water table in the landfill.

3.4.3 Groundwater Analytical Results

Analysis of the groundwater (leachate) obtained from monitoring wells installed in the refuse and surrounding areas were completed to determine the overall chemical characteristics of the groundwater/leachate and to determine if there were any changes in chemistry with time. Tables E-10, E-11, E12 and E-13 (Appendix E) summarize the results of the groundwater/leachate analyses.

Tables E-10, E-11and E-13 indicate that the groundwater/leachate samples collected generally meets the Table B groundwater non-potable criteria except for the parameters and locations shown on Table 3.

Table 3: Summary of Groundwater/Leachate Exceedances

Parameter	Criteria **1	Exceedance Location, Date and Results		
		Location	Date	Result
Copper	0.023 mg/L	MW6-21 MW6-51A G-4	Feb 12/99 May 18/00 June 21/00	0.14 mg/L 0.026 mg/L 0.4 mg/L
Lead	0.032 mg/L	MW6-21 MW6-23 MW6-25 MW6-42 MW6-43 MW6-44	May 10/00 May 10/00 May 10/00 Oct 13/98 Oct 13/98 Oct 13/98	0.075 mg/L 0.166 mg/L 0.045 mg/L 0.31 mg/L 0.11 mg/L 0.13 mg/L

Parameter	Criteria **1	Exceedance Location, Date and Results		
		Location	Date	Result
Mercury	0.12 μg/L	MW6-12 MW6-13 MW6-43 (Dup) MW6-50 MW6-51A MW6-51B MW6-59 MW6-60 GW-6	May 9/00 Sept 25/97 May 9/00 Oct 13/98 May 11/00 May 18/00 May 17/00 July 12/00 July 12/00 June 21/00	0.2 μg/L 0.14 μg/L 0.9 μg/L 0.19 μg/L 0.2 μg/L 1.2 μg/L 0.5 μg/L 0.3 μg/L 0.3 μg/L 0.2 μg/L
Selenium	0.05 mg/L	MW6-42	May 10/00	0.2 mg/L
Cyanide (total)	0.052 mg/L	MW6-13	May 10/00	0.071 mg/L
Vinyl Chloride	0.5 μg/L	MW6-11 MW6-60	May 9/00 July 12/00	14 μg/L 17 μg/L
1,1-Dichloroethene	0.66 μg/L	MW6-60	July 12/00	2 μg/L
cis-1,2-dichloroethylene	70 μg/L	MW6-60	July 12/00	250 μg/L
Trichloroethene	50 μg/L	MW6-60	July 12/00	250 μg/L

Notes: **1– Criteria used was the non-potable (Table B) groundwater criteria from the MOE Guideline for Use at Contaminated Sites in Ontario, 1996, revised 1997.

In addition to the above exceedances, the EQL or method detection limit for certain parameters was above the respective Table B groundwater criteria for some samples.

All of the groundwater exceedances for VOCs to date have been reported from MW6-60 with the sole exception of vinyl chloride at MW6-11. MW6-60 is located at the Hamilton Street Pallet Company site. Drilling at MW6-60 did not intersect any waste and the location of this monitor appears to be up-gradient of the landfill. The source of the VOCs at MW6-60 are therefore unknown at this time. The groundwater at MW6-60 needs to be resampled for VOCs to confirm this initial result.

Table E-12 indicates that analyses for PCBs have been conducted on 46 groundwater/leachate samples. The reported range of PCBs concentrations was from less than 0.2 μg/L (the EQL) to 230 μg/L in the sample from MW6-57. The Table B PCB groundwater criterion of 0.2 μg/L was exceeded in 22 samples but PCBs were not detected in 17 samples. Figure 10 shows the distribution of the PCB concentrations in leachate and in the seeps along Red Hill Creek. As indicated, most of the PCB exceedances have been from monitoring wells in the southern portion of the former landfill. The result from MW6-57 needs to be confirmed because although it is in the southern portion of the landfill, it is situated near the interpreted western edge of the main area of waste.

The PCB analyses have been carried out on unfiltered samples. The use of unfiltered samples would be expected to produce the higher PCB result because PCBs are hydrophobic and would therefore tend to bind to solid material within the liquid sample. The PCBs result from MW6-57 resembled Aroclor 1242 and the generally accepted maximum solubility is in the range of 200 to 500 μg/L (Mackay et. al., 1992). This means that the reported concentrations of PCBs at MW6-57 of 230 μg/L is close to its reported solubility.

Comparison of indicator parameters (parameters that have relatively high concentrations in the leachate) reported to date in the former Rennie Street Landfill, typical leachate concentrations in Ontario and the sanitary sewer discharge criteria (Regional Municipality of Hamilton-Wentworth Sewer Use By-law R89-049) are presented in Table 4.

Table 4: Comparison of Indicator Parameters

Indicator Parameter	Sanitary Sewer Use Criteria **2 (mg/L)	Average Leachate Concentration (mg/L)	Typical Leachate Concentration in Ontario**1 (mg/L)
Calcium	nv **3	120	25 - 2,860
Iron	50	10	0.3 - 1,910
Magnesium	nv	100	80 - 694
Sodium	nv	3,200	911 - 2,030
Alkalinity	nv	2,000	1,200 - 2,900
Chloride	1,500	6,300	35 - 4,670
TKN	100	440	434 - 931
BOD	300	130	0 - 1,000

Notes: **1 – R. Kerry Row Inc., 1994, *"Leachate Characterization"*, Interim Waste Authority.

**2 – Sanitary Sewer Discharge Criteria, Regional Municipality of Hamilton-Wentworth Sewer Use By-law R89-049

**3 – No value

Chloride concentrations showed one of the greatest range of values varying from 213 mg/L (MW6-52A) to 26,600 mg/L (MW6-13). Sodium also had a wide range of values with results varying from 100 mg/L (MW6-50) to 17,200 mg/L (MW6-13). Overall, the concentration of chloride and sodium are higher than what is typically found in landfill leachate (Table 4). The elevated chloride and sodium concentrations are at least partly due to the road salt storage dome located on the Public Works Yard. Figure 11 shows the chloride concentrations in the groundwater and seep samples. As indicated, there are several areas with elevated chlorides. The two areas with the highest chloride concentrations are along the north-south ravine and in the northern section of the main area of waste (between MW6-42 and MW6-13).

The organic strength of the leachate (TKN and BOD) is lower than typical landfill leachate which may be related to the relatively older age or composition of the waste at the former Rennie Street Landfill.

Table 4 indicates that the average leachate concentration is close to the Sanitary Sewer Use By-law limits and such could be considered for disposal in the sewer if this activity is required as part of any remedial activities.

3.5 Surface Water Analytical Results

Surface water samples were taken from Red Hill Creek, upstream at the CN embankment (SW1) and downstream (SW5) from the site just below the footbridge on two dates (Oct 13/98 and May 16/00). The purpose of these samples was to determine if there was any change in water quality in Red Hill Creek that may be caused by leachate impacted groundwater discharging into the creek. The analytical results for these samples are included on Tables E-14, E-15 and E-16 in Appendix E.

Tables E-14, E-15 and E-16 indicate that overall the water quality within Red Hill Creek (SW1 and SW5) is generally good with only exceedances of the PWQOs for four parameters (aluminium, lead, phenolics and total phosphorous). VOCs and PCBs were not detected in these surface water samples during sampling completed to date. Comparison of the concentration of indicator parameters (parameters that have relatively high concentrations in the leachate) collected upstream (SW1) and downstream (SW5) of the landfill is presented below in Table 5.

Table 5: Surface Water Impact Analyses

Indicator Parameter	Upstream Concentration (SW1)		Downstream Concentration (SW5)		Average Concentration In Seeps	Average Concentration in Leachate
	Oct 13/98	May 16/00	Oct 13/98	May 16/00		
Ammonia	0.4 mg/L	<0.05 mg/L	0.32 mg/L	0.11 mg/L	13.5 mg/L	276 mg/L
Chloride	112.2	<2 mg/L	123 mg/L	<2 mg/L	7300 mg/L	6300 mg/L
Sodium	70.6 mg/L	173 mg/L	70.3 mg/L	184 mg/L	4570 mg/L	3200 mg/L
TKN	17.9 mg/L	0.48 mg/L	4.2 mg/L	0.39 mg/L	340 mg/L	440 mg/L
Iron	0.06 mg/L	0.07 mg/L	0.02 mg/L	0.22 mg/L	460 mg/L	10 mg/L
PCBs **1	<0.01	N.A.	<0.01 µg/L	N.A.	33 µg/L **1	15 µg/L

Notes: N.A – Not Analyzed
** – PCB samples were not filtered. PCBs are hydrophobic and therefore the reported PCBs concentration are expected to be related to PCBs both on the solid material and in the liquid portion of the sample.

Table 5 shows that only ammonia and iron show a significant increase in concentration and the only increase in these parameters is during the May 16, 2000 sampling event. The increase in the ammonia between SW1 and SW5 on May 16, 2000 corresponds to a proportional decrease in the TKN concentration (which includes ammonia), so there does not appear to be any net increase in nitrogen concentration that would be expected if ammonia was impacting the creek. The increase in the iron

concentration in the creek during the May 2000 sampling event is inconclusive because the magnitude of this increase (i.e. three times greater) is the same magnitude as the decrease in the iron concentration that was observed between these same sampling locations in October 1998. Therefore the observed variability in the sampling results is interpreted to be due to variability in sample collection and/or analyses.

In conclusion, there is no significant difference in concentrations for these parameters and therefore it can be concluded that the groundwater discharges to Red Hill Creek have essentially negligible effect on the surface water quality. Given the observed flow in the Red Hill Creek and the estimated groundwater flow into the creek it is reasonable to expect that the former landfill would not affect the surface water chemistry.

3.6 Outfall Analytical Results

Five outfalls (P1, P2, P3, P4 and P9) were sampled between Oct 13/98 and May 8/00, these are the only outfalls that are observed to flow on a regular basis. The results from these samples are summarized in Tables E-14, E-15 and E-16 (Appendix E). Initial samples (Oct, 1998) from P3 and P4 were collected from depressions near storm sewer outfalls in order to replicate sampling conducted by the MOE. The sample from the storm sewer outfall at P9, which was collected at SW6, was from a small creek that runs from this outfall along the Brampton Street right-of-way. This sample contains both the storm sewer outfall at P9 and a small tributary that comes from the Brampton Street Landfill.

The earlier sampling results (Oct 13/98) from P1, P3, and P4 all had relatively good water quality and no VOCs or PCBs were detected above their respective method detection limits (MDLs) from these outfalls during this sampling event. The reported MDL for PCBs was unfortunately greater than the PWQO PCB criterion of 0.001 μg/L due to the difficulty in attaining this standard. The later sampling of P2 and P3 showed that the water quality from these storm sewer outfalls does not meet PWQOs. The water quality from P2 and/or P3 shows impacted water quality with exceedances of the PWQOs for aluminium, boron, cadmium, cobalt, copper, iron, lead, uranium, zinc, ammonia, total phosphorus and PCBs. All of the analyzed VOCs were less than their PWQO criteria but there were three VOCs detected in the P2 sample and one VOCs detected in the P3 sample.

The source area for P3 is not known but it suspected that it runs slightly north of Rennie Street, this outfall is going to be blocked. P2 drained a portion of the Public Works Yard and subsequent to the sampling at P2 this outfall was blocked.

The water quality from P9 that was collected at SW6 is slightly worse than the water quality in Red Hill Creek at the tested locations (SW1 and SW5),with exceedances of the PWQO criteria for aluminium, boron, cobalt, lead, and phenolics. Four VOCs were also detected in this sample but at concentrations that were less all than their PWQO criteria. No PCBs were detected in this sample at the EQL indicated.

In summary, the water quality in the outfall or sewer discharge samples ranged from good to poor. Samples from these outfalls generally conform with the PWQOs but there are exceedances for one or more parameters at every location. The contribution of impacted groundwater to these sewer discharges are not known but based on chemistry and water colour it is suspected that at P3 leachate/groundwater is a significant portion of the flow.

3.7 Seep Water Analytical Results

Ten water samples were collected from selected seeps along the bank of the Red Hill Creek between Nov 29/99 and May4/00. These samples were collected by letting these waters flow into a collection container, and then transferring the sample into the appropriate containers. The analytical results from this sampling are summarized in Tables E14, E-15 and E-16 (Appendix E).

These results indicate that these waters exceed the PWQOs for several parameters including un-ionized ammonia, iron, copper, lead, phosphorous and phenols. Additional parameters for which there are no PWQOs were also found to be elevated in these waters (e.g. chloride and sodium). Several factors should be noted at this time:

- These samples were collected from a man-made depressions as close to the seep locations as possible. As a result, the samples did contain significant quantities of sediment. These samples were not filtered so these results would contain the influence from both the soil grains themselves and any material that was bound to the grains (this is especially an influence on the metal and PCB results).

- These results are compared to PWQO criteria. These seeps are arguably classifiable as "mixing zones" under the PWQO guideline, although this would require MOE designation. Mixing zones are areas were exceedances of the PWQOs may be allowed. The PWQOs also indicate that mixing zones should be as small as possible and that they are not to be used as an alternative to "reasonable and practical treatment". To determine the appropriate criteria for these zones would require deriving effluent concentrations which are outside the scope of this investigation.

3.8 Creek Bank Soil Analytical Results

The surface creek bank soil samples from all of the seeps identified up to May 1, 2000 (S1 to S26, inclusive) were sampled between October 21/98 and May 3/00. The results of these analyses are summarized in Appendix E on Table E-17. Generally these samples were analyzed for benzene, toluene, ethylbenzene and xylenes ("BTEX" compounds), TPH and PCBs.

In September 1997, the MOE completed a bank soil/sediment sampling program in Red Hill Creek north from the CN Railway to the Queen Elizabeth Way. Four sediment sampling locations in the MOE study were adjacent to the Rennie Street Landfill. The sediment samples were analyzed for metals, VOCs , PAHs and PCBs. The concentrations of most parameters were not significant with the exception of a high PCB concentration of 90 mg/kg in the bank soil sample taken just north of

the Rennie Street alignment. A water sample was also taken from the storm sewer outfall south of the seep. This sample had an elevated iron concentration of 5.41 mg/L compared to a PWQO of 0.3 mg/L.

The purpose of the initial creek bank sampling conducted by Dillon in October 1998 was to confirm the soil sampling conducted by the MOE along Red Hill Creek. At the seep located at S26 (previously called SW2) two surficial samples were collected for PCB analyses, SW2A consisted of oily-sediment and SW2 consisted of soil that was discoloured from the discharge of the seep. PCBs were not detected in the soil sample from this location but the oily-soil sample (from the point of seepage) had a PCB concentration of 98 mg/kg. The reported PCBs concentration in the oily-soil sample is comparable to a sample taken by the MOE in September 1997 which had a concentration 90 mg/kg.

Further detailed sampling of the sediments in the vicinity of the oily seep at S26 was completed to further delineate PCB concentrations. The results of this detailed investigation are summarized in Appendix F. Five samples, taken at a depth of 0.15 m, had PCB concentrations ranging from 0.06 mg/kg to 0.71 mg/kg. The sediment sample taken 0.15 m below the oily seep had the lowest PCB concentration (0.06 mg/kg). These impacted soils were later removed as part of a remedial investigation conducted at this location.

Table E-17 (Appendix E) indicates that the surficial soil samples from the creek bank have a large variability in the concentrations of the tested parameters. The reported PCB concentration in these soil samples ranged from less than the EQL or method detection limit (<0.05 μg/g) to 1,500 μg/g at S4. The soil sample from S5 had the highest reported concentration of the BTEX compounds (which are the volatile portion of petroleum hydrocarbons) and TPH. The soils at S5 also had a PCB concentration of 34 μg/g. Seep S5 has a very low observed flow and the amount of staining at this location is inconsistent with the reported TPH results. The source of the elevated chemistry is thought to be the tar-like substance in the three drums that were previously removed from this location. These drums contained a black tar-like substance that was found to be petroleum based and to contain high concentrations of PCBs (maximum of 1,200 μg/g).

3.9 Landfill Gas

Landfill gas was monitored in on-site gas monitoring wells between October 1998 and July 2000. In addition, the gas concentrations in on-site buildings and neighbouring homes was also collected. The results of this monitoring is included in Appendix C. Heath Consultants was also retained to further investigate the distribution of and nature of the combustible gases in the area. Heath Consultant's report is also included in Appendix C.

Landfill gas is generated as solid waste decomposes in the landfill. Landfill gas typically consists of carbon dioxide and methane in roughly equal portions. Landfill gas is expected to occur within the waste at the landfill. The potential for landfill gas to migrate from the landfill to the west was investigated by installing gas monitors in the Public Works Yard west of the railway spur. Based on the results of this testing, landfill gas is present over much of the Public Works Yard. Concentrations

ranged from near background levels at GW1 and GW5 to over 50% gas at GW3 and GW6. The presence of such high levels of landfill gas is attributed to the presence of the north-south ravine which has been filled with waste/refuse and into which GW6 and possibly GW3 are completed. Combustible gas was not found in significant quantities in on-site buildings or in nearby residential homes. Results of bar testing along the western property boundary by Heath Consultants indicated no positive readings in the area indicating that migration off-site is not occurring. Combustible gas testing indicated that combustible gas is not migrating off-site west of the Public Works Yard.

Overall, the investigations identified the presence of landfill gas within the Public Works Yard. The results of the source evaluation completed by Heath Consultants by completing gas chromatography on samples of soil gas at the Public Works Yard, gas from a monitoring well installed in the main waste mass east of the railway spur and a sample of product Natural Gas taken from the distribution meter at the site indicated that the source of the gas is from decaying waste. It is not possible to discern if the gas is from the waste present in the north-south ravine or is from the main waste mass east of the railway spur.

3.10 Slope Stability

Peto MacCallum Limited (Peto) and Water Regime and Simulations Limited (Water Regime) were retained to assess the east slope of the landfill. Their reports are included in Appendices H and I. Their findings indicate that the slope is currently stable but that the bank is being eroded by the creek. It is not known when this erosion will cause bank stability problems.

4.0 SUMMARY OF CONCLUSIONS

The following is a summary of conclusions related to waste, leachate and landfill gas based on the results of the investigative work at the former Rennie Street Landfill:

Waste Quality and Quantity

The Public Works Yard covers an area of approximately 95,000 m^2, most of which is constructed on fill material or landfilled waste. It is estimated that approximately 400,000 m^3 of waste has been landfilled at the site and it covers approximately 85,000 m^2 of the site. The main waste mass occurs between the railway spur and Red Hill Creek and the depth of waste in this area is up to 11.3 m. This landfill was created by filling in the floodplain of Red Hill Creek. There are also two ravines that previously existed on the site that had been filled with waste/refuse and/or fill. The larger ravine ran north - south, parallel to Waterloo Street within the Public Works Yard. The second smaller ravine ran east-west just north of Rennie Street.

The site geology generally consists of a thin layer of recent fill and/or street sweepings at the surface, overlying either refuse/waste or silty clay till (Halton Till). These units are in turn underlain by a shale bedrock (Queenston Shale).

The eastern slope of the landfill forms the west bank of Red Hill Creek. Bank erosion, up to about 0.3 m/year at some locations, is occurring along the landfill slope. Although there is no imminent risk of the slope collapsing, the erosion will at some point in the future lead to bank failure.

The general chemical characteristics of the native soil underlying the waste were all less than the Table B industrial/commercial criteria except for the zinc concentration in one sample. These results suggest that the native underlying soils have not been significantly impacted by the landfilled waste.

Four waste samples were extracted in accordance with the Regulation 347 leachate procedure and analyzed for metals. These Regulation 347 metal analyses indicated that the waste would be classified as non-hazardous. Three other waste samples had total PCB concentrations that were greater than 50 mg/kg indicating that the waste in these locations would be classified as a hazardous waste. These analytical results suggest that the waste would be classified as non-hazardous except where the total PCB concentrations are greater than 50 mg/kg.

Leachate

Based on water levels collected to date, shallow horizontal groundwater flow in both the overburden/waste and shallow bedrock groundwater flow systems are generally from the western side of the landfill east towards the Red Hill Creek. This groundwater flow results in the presence of seeps along the west bank of Red Hill Creek. The 90-inch watermain that runs north - south just east of the western property boundary is inferred to have a significant localized effect on groundwater

flow in the shallow flow system. The sand and gravel bedding of this watermain appears to be acting as a conduit for water that is flowing onto the site and some of the groundwater that recharges on-site in the immediate vicinity of this service. In addition the north-south ravine may also be having a minor effect on groundwater flow, directing some groundwater to the north, towards the Brampton Street Landfill.

Vertical groundwater flow is downward from the shallow groundwater flow system into the shallow bedrock. Groundwater in the shallow overburden along the creek flows into both the deeper bedrock flow system and also into the creek. The vertical movement of groundwater flow in the fill and waste over the majority of the site is limited by the presence of a silty clay till layer which retards or slows this movement. The effect of this silty clay till layer is to direct groundwater flow horizontally towards the creek. Some groundwater does flow through the silty clay material and/or flows through "windows" in this unit into the shallow shale bedrock. These "windows" or holes can be either man-made such as backfill along the 90-inch watermain and/or areas where this unit is absent.

Leachate quality at the site is basically similar to typical landfill leachate. The PCB concentrations in the waste in the southern portion of the landfill are also higher than typical domestic landfills with reported concentrations of up to 620 μg/g. Chloride and sodium concentrations are also slightly greater than typical leachate quality which may be due to road salt storage at the Public Works Yard. The organic strength of the leachate (BOD and TKN) is less than typical landfill leachate which may be due to the age of the landfill.

The reported range of PCBs concentrations in the leachate was from less than 0.2 μg/L (the EQL) to 230 μg/L. Most of the PCB exceedances are from the southern portion of the former landfill.

The water quality of the seeps is generally similar to the leachate quality of the landfill with exceedances of the PWQOs for several parameters. In addition, several other parameters for which there are no PWQO criteria were also found to be elevated in these waters (e.g. chloride and sodium). Some of these seeps have also been observed to contain a PCB-contaminated oily product.

Sampling of bank soils from seep locations on the west bank of Red Hill Creek indicated that the surficial soil samples from the creek bank have a large variability in the concentrations of the tested parameters. The soils along the bank have been contaminated by the discharge of leachate in the seeps and particularly PCB-contaminated oil associated with the leachate.

Landfill Gas

Landfill gas was detected over much of the landfilled area, including the detections of very high concentrations in the vicinity of the Public Works Yard buildings. Monitoring along the western property boundary and in residences west of the yard indicates that landfill gas is currently not migrating west.

Surface Water Quality

As previously discussed, leachate is discharging from the landfill along the west bank of Red Hill Creek. As well, there are a number of storm sewers that outfall to the creek along the west bank. The storm sewer discharges and outfalls in the area of the former Rennie Street Landfill have good to moderate water quality. However, there are exceedances of one or more PWQOs at each of the tested locations. The presence of these buried utilities may be assisting with the migration of leachate to the creek. The contribution of impacted groundwater inside these sewers and outside (in bedding materials) is not known.

Sampling and analysis of water from Red Hill Creek has indicated that upstream and downstream water quality is similar. The impact from the discharges to the creek is not quantifiable.

5.0 REMEDIAL ACTIONS

Based on the investigations completed at the Rennie Street Landfill, it is recommended that the remedial works include the following:

- collection of the leachate before it can discharge to the creek,
- erosion control of the west bank of the creek to prevent future exposure of the waste and discharge of contaminants to the creek,
- restoration/remediation of the west bank of the creek where it has been contaminated by the seepage,
- clean-up of the creek,
- control of landfill gas to prevent off-site migration and accumulation in on-site buildings, and
- elimination of leachate migration in and around storm sewers that cross the landfill.

5.1 Interim Controls

In December of 1999, interim measures were implemented to control, to the extent possible, the on-going discharge of contaminated soil and oily leachate into Red Hill Creek. However, these interim controls are not effective at preventing the discharge of dissolved contaminants in the leachate into the creek. The interim controls included the installation of silt fences and absorbent booms/pads at all identified seep locations. The leachate passes through the absorbent booms and pads and through the silt fence, trapping the separate phase contaminants (oil with PCBs) and soil. To-date approximately 25 separate seeps have been identified and protected with silt fences and absorbent material. The larger seeps have been protected with two and sometimes three separate layers of silt fence and absorbent material.

Since March 2000, the west bank is inspected daily and the condition of the silt fences and absorbent booms are recorded. Damage to the fences and booms/pads are repaired immediately, subject to accessibility of the impacted area . Absorbent booms and pads are replaced as they become saturated. To-date approximately 40 205-litre drums of saturated booms and pads have been collected and replaced. As well, silt fences are installed at new seeps as they are identified during the daily inspections. Appendix K includes a copy of the Silt Fence and Boom Inspection/Maintenance Program.

Due to the extremely wet weather conditions experienced in the spring and summer of this year, damage occurs frequently and has resulted in the discharge of oily leachate to the creek on a number of occasions. It should also be noted that although seeps have been observed at the landfill for a number of years, the number and severity of the seeps has increased over the past year. The contractor maintaining the interim measures has been instructed to replace and repair the measures as soon as possible after damage occurs, once it is safe for workers to access the area.

In order to prevent dissolved contaminants in the leachate from reaching the creek until the permanent collector can be installed, two localized leachate collection systems were installed on the west bank of the creek. The design of the collector is attached as Figure 10. The collectors were constructed in a shallow excavated trench (1.0 m deep) into the bank of the landfill immediately below and between seeps S4 to S20 and at seep S19 (see Figure 2).

At the southerly collector (S4 to S20) a perforated pipe was installed and the excavation backfilled with clear stone. The backfilled trench was then covered with plastic to keep surface water from infiltrating and the perforated pipe was connected to a buried storage tank. At the northerly collector (S19), the storage tank was buried into the bank and a berm placed below the tank to direct leachate into it.

Leachate is removed from the buried tanks and is pumped using a pneumatic liquid pump operated with a gas powered air compressor. The pneumatic pump was selected because it is explosion proof and can provide the high head required to pump the water to the top of the landfill. The pumped leachate is then stored in steel storage tanks until sufficient quantity is accumulated for off-site disposal at a licensed waste disposal facility.

When first installed, approximately 500 litres of leachate was being collected weekly. Once modifications were made to the collectors, this volume increased considerably. Disturbing the surface of the bank by excavating the trench and burying the storage tanks has resulted in a more direct hydraulic connections being made with the leachate inside the landfill to the collection system. Previously, this leachate was likely being held back by the surficial material. Most recently, with the assistance of a vacuum truck pumping the buried storage tanks, approximately 20,000 litres of leachate was collected within a one week period. To-date, approximately 45,000 litres of leachate has been removed from the two collectors.

Over the course of collecting leachate, it became evident that approximately two days after a significant rain event, the collectors filled very quickly. With the extremely wet spring and summer this year, these events have occurred on at least a weekly basis. The collectors appear to collect about 80% of the leachate that would have discharged to the creek prior to their installation. The installation of additional collectors and automating the existing two is currently being discussed.

The installation of the localized collectors has provided valuable information on landfill conditions at the bank. When the bank was excavated and the landfill exposed, the nature of the wastes could be observed over a fairly large area. The waste in this area is extremely variable in composition and included large boulders, concrete blocks and logs. Pockets of leachate were observed to have accumulated behind these large objects. Due to heterogeniety of the waste at the banks, the seeps occur at various elevations and flows are not consistent from one seep to another, or even from the same seep over time.

Operation of the interim controls will continue while the long-term solution is being designed and appropriate approvals obtained.

5.2 Alternatives

Options for carrying out the long-term remedial works were identified and evaluated. A summary of this evaluation is included in Table 6.

Alternatives to mitigate creek bank erosion are described in Section 5.2.1. Alternatives that address the issues of preventing seeps from the landfill from reaching the creek and bank and creek remediation are discussed in Section 5.2.2. Some alternatives in each section may address more than one issue. This is described with each alternative. The evaluation and identification of a preferred solution is based on the premise that an alternative or combination of alternatives must provide a long-term solution to meet all of the identified needs. An action plan to deal with buried utilities and outfalls in the landfill is described in Section 5.2.3.

The criteria used to evaluate the alternatives included:

- Effectiveness – there must be a reasonable certainty that the alternative would be effective at addressing the specific issue,
- Feasibility and Lifespan – the alternative must be readily constructable with a reasonable expectation to operate as intended. The alternative must provide a long-term permanent solution to the issue. Alternatives that will require significant maintanance or with relativley short life spans are not preferred,
- Health and Safety Risk – alternatives that minimize the health and safety risk to workers and the community are preferred, and
- Cost – the preferred alternative must be cost-effective.

The alternatives were qualitatively assessed using the above criteria. The following sections provide a summary of this evaluation and the rationale for identifying the preferred alternative. The purpose of the following description is to identify the key reasons for the elimination or selection of specific alternatives.

5.2.1 Bank Erosion Alternatives

In-place Lining of Existing Bank

This alternative requires the use of either gabion baskets, armour stone, concrete or a similar material to construct a vertical (or stable profile) wall along the western (outer) bank of the existing stream footprint in areas of concern to mitigate stream bank erosion. The lifespan of this alternative is limited to between 15 and 60 years before failure occurs or replacement is required. In order to construct the wall, excavation of waste behind the wall will be required. This will create a significant

Table 6: Alternative Ways to Manage the Problem

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Do Nothing	maintain status quo	none	N/A	N/A	not effective	continued environmental degredation	no change	no	no	$0	This alternative does not address any of the identified problems
Remove Landfill	all of the waste in the landfill would be removed to a licensed facility	MOE	2 - 4 years	very difficult	likely	removal of creek west bank vegetation, replacement of entire site with vegetation	prolonged noise, odour and truck traffic during removal	yes	no	$26 million	This is the total removal of waste from the site, it will produce severe and prolonged impacts to the neighbourhood and is extremely expensive
Purge Wells	leachate extraction wells installed along top of landfill to prevent leachate from reaching the bank	none	2 months	easy	further testing req'd	negligible	negligible	no	yes	$750,000 without treatment plant	Produces large volume of leachate for treatment, effectiveness unknown, test well results were not favourable
Trench West of Top of Slope	horizontal collector installed in waste to collect leachate before it reaches bank	none	3 - 6 months	very difficult	should be effective	negligible	some dust and odour during construction	no	yes	$2.81 million without treatment plant	Produces large volume of leachate for treatment, very difficult to construct because of depth
Retaining Wall at Creek	large concrete retaining wall along entire bank of creek, leachate collected in pipe behind wall	DFO/CA	6 - 12 months	extremely difficult	probably effective	complete destruction of fish habitat along west bank	some dust and odour during construction	yes	unknown	$9.85 million without treatment plant	Extremely large concrete structure that would isolate the landfill from the creek. Downstream impacts unknown
Regrade Slope	remove waste from slope of landfill and install collector at base, adjacent creek	DFO/CA	3 - 6 months	moderate	likely	complete destruction of west bank of creek, mitigatable with replanting	some dust and odour during construction	not completely	unknown	$4.13 million without treatment plant	Requires movement of large volume of waste and re-piling on site
Relocate Creek	recreate natural floodplain to ensure long-term stability of creek, install leachate collector at base	DFO/CA	3 - 6 months	moderate	likely	net improvement in fish habitat, vegetation replanted	some dust and odour during construction	yes	unknown	$2.41 million without treatment plant	Provides separation of creek from landfill and creates area to install leachate collector
Install Cover on Landfill	install low-permeable cover on landfill to prevent water from entering the landfill and creating leachate	none	2 - 3 months	easy	likely	negligible	some dust and odour during construction	no	N/A	under development	Installing cap should help limit amount of leachate that is created
Install Perimeter Drain	a collector drain would be installed around west, north and south sides of landfill to collect groundwater before it enters the landfill	none	2 - 3 months	easy	likely	negligible	some dust and odour during construction	no	N/A	under development	Installing drain would further decrease amount of leachate being created. Testing required to ensure effectiveness
Remove Services Through Landfill	numerous sewer and water-main pipes cross the landfill removing the pipes will eliminate leachate conduits	none	2 - 3 months	moderate	likely	negligible	some dust and odour during construction	no	N/A	under development	Removing obvious conduits will help eliminate leachate discharges
Install Localized Collector at Seeps	installing collector pipes in the bank at the seeps that drain to a holding tank to prevent seeps from reaching the creek	CA	1 - 2 months	moderate	likely	small areas of vegetation removed	negligible	no	no	under development	This alternative needs to be tested to determine effectiveness

MOE - Ministry of the Environment *DFO - Department of Fisheries and Oceans* *CA - Conservation Authority* *N/A - Not Applicable*

health and safety risk for workers and area residents. Vegetation from the entire west bank will require removal.

Footings for the wall would be constructed below creek level. A temporary barrier and dewatering will be required in order to construct the wall adjacent the creek. High creek flows during construction would cause significant damage including the erosion of the exposed waste into the creek. This alternative will address bank remediation in some areas but additional remediation in other areas may be required. This alternative does not address creek sediment remediation.

This alternative does not provide a mechanism to reduce in-stream energy and as a result downstream areas may experience greater stream power, higher shear stress and increased rates of erosion. Downstream impacts in the area of the Brampton Street Landfill would likely be significant.

In-place Lining of Relocated Bank

A variation to the previous alternative, this alternative involves constructing the bank lining 1 to 3 metres into the existing stream channel. This would result in the net decrease in width of the channel. However, significant excavation of waste in the existing bank would not be required to construct the wall. Since this alternative increases channel incising, the result would be an increase in bank shear stress. This will likely cause a significant increase in erosion of the opposite bank. Also, this alternative will result in further increased downstream erosion in the area of the Brampton Street Landfill, due to the increased stream energy that it causes. Also, because of the increased stream power, the anticipated lifespan of this alternative would be relatively shorter.

This alternative would address bank remediation in most areas and it partially addresses creek sediment remediation in the area of the creek that is covered. Vegetation from the entire west bank would be removed and similar to the previous alternative, a temporary barrier dewatering will be required during construction.

Lining of Entire Channel

This alternative involves lining the entire creek channel with concrete. All concerns associated with bank erosion would be eliminated. However, it would involve the permanent destruction of fish habitat in the area. This alternative addresses bank remediation and creek remediation by encapsulating and isolating the contaminated material from the creek and terrestrial environment.

Vegetation on both sides of the creek as well as all fish habitat would be permanently removed. Temporary diversions or pumping of the creek would be required in order to construct this channel. Any significant storm during the construction of this alternative would severely impact the work and risk to the creek.

Creek Relocation in Naturalized Channel

This alternative emulates (although limits) the natural tendencies of the creek. This involves the excavation of material on the east side of the creek to construct a new stable channel and floodplain. The new channel would be constructed 5 to 10 metres east of its existing location in order to establish a floodplain bench along the western bank and a stable landfill slope. The bank full width of the creek would be reduced from approximately 16.5 metres to 13 metres (with a proportional increase in depth) in order to prevent sediment build-up. A floodplain stage on the east side of the creek would be constructed 10 to 15 metres wide. Rock veins and cross veins would be installed to mitigate near bank shear stress and eliminate bank erosion. This alternative does not require excavation of landfill material on the west side of the creek. There are reports of buried ash on the east side of the creek, north of Brampton Street, that may require excavation as part of the construction of this alternative. The extent and location of the potential ash is being investigated.

The construction of the erosion prevention structures provides a diversity in hydraulic conditions and changes in streambed elevations, which increases the myriad of local fisheries habitat. Although there will be some downstream impacts in the area of the Brampton Street Landfill, they will not be as severe as the previous alternatives because stream energy is not increased and the wider floodplain will allow for more storage during high flows.

This alternative addresses bank remediation and creek remediation by encapsulating and isolating the contaminated material from the creek and terrestrial environment. All of the vegetation on the west and east sides of the creek would be removed during construction and subsequently replaced with native species, consistent with the Red Hill Creek Watershed Plan, after the creek is relocated.

Relocating the creek in a natural channel to the west of the existing stream, into the area of the landfill is not feasible. This would require the excavation and disposal of approximately 100,000 cubic metres of waste. The health and safety risk to the workers and community would be significant. The creation of the natural channel and stable slopes requires a large volume of fill material to construct the landform, this material is available from the east side of the creek, but not from the west side. Relocating the natural channel to the west into the landfill would require the importation of a large volume of clean fill from other sites. If the natural channel is located to the east, the excavated material is ideal for constructing the new banks and floodplain and surplus material may be utilized for contouring the top of the landfill.

Evaluation

Lining of all or part of the creek with engineered, vertical erosion prevention measures will have a limited lifespan of between 15 and 60 years. As such, these measures will not provide a permanent long-term solution to erosion of the bank of the landfill. Additionally, the downstream erosion impacts created by these alternatives are not acceptable. Lining of the entire channel with concrete results in the permanent and total destruction of fish habitat and vegetation on both sides of the creek. Partial lining of the creek (west bank) will result in the total destruction of vegetation on that bank. These alternatives are not consistent with the intent of the Red Hill Creek Watershed Plan.

Relocating the creek in a naturalized channel is the only alternative that addresses the need for long-term bank stability. The natural channel alternative will create the least downstream bank erosion impacts of any of the alternatives. It also addresses the issues of bank and creek remediation. Although vegatation and fish habitat are initially damaged during construction, significant opportunities for enhancing fish habitiat and replacment of the removed vegetation are provided. Creating the natural channel to the east is recommended because the movement and disposal of waste is avoided and it provides the fill material required to create the channel and floodplain. Mitigation will be required for the potential erosion impacts to the Brampton Street Landfill.

Due to the necessity for long-term erosion control of the west bank of the creek, relocating the creek in a naturalized channel towards the east is recommended.

5.2.2 Leachate Seepage Control

Do Nothing

The "Do Nothing" alternative is not a feasible or an acceptable alternative from an environmental or regulatory perspective. Permitting the continued discharge to the creek of leachate seepage from the landfill does not address any of the identified needs. This alternative is eliminated and not considered further.

Limit Leachate Generation

The amount of leachate expressed from the landfill is linked to the volume of leachate within the landfill. By controlling the volume of leachate that is generated, it is anticipated that the volume of the leachate escaping in the seeps will decrease. Leachate in this landfill is generated through the infiltration of surface water and the flow of groundwater from upgradient areas. The volume of leachate generated within the landfill can be controlled through the installation of a low permeability cover and drainage system over the landfill and the installation of an upgradient collector at the western limit of the landfill. The impact of limiting leachate generation will be to decrease the volume of leachate being expressed from the slope adjacent the creek; however, it is not likely to entirely prevent the discharge to the creek.

Landfill Removal

The removal of waste from the landfill would eliminate the potential for leachate from the landfill from impacting the creek. This alternative would also address bank remediation, as the bank would be removed with the landfill. Removal of the estimated 400,000 m^3 of waste from the site would require approximately 50 trucks per day, 180 days per year for four years. Creek remediation would not be addressed and would require additional work.

All of the leachate contained within the landfill will have to be removed, treated and/or disposed if the waste were to be excavated. The cost for the total removal of the landfill could range from $20 million to more than $100 million depending on the quantity of PCB contaminated soil and volume of leachate requiring disposal

Excavating and removing the waste will introduce significant air quality impacts on the community for an extended period of time. Also, there would be a significant health and safety risk for the workers completing the work and the community.

Since the lower limit of the waste is lower than the creek and the waste extends to the bank of the creek, excavation of waste will be difficult. A temporary barrier would be required to contain the creek within its present banks. Since, during storm events the creek level can increase more than seven metres, any significant storm during the excavation of the waste will likely flood the area.

In the last two years the creek has exceeded its bank-full level approximately 8 times per year. Since the excavation of waste will require a number of years to complete, it is likely that the landfill area would be flooded a number of times.

Excavation of the waste will require the complete removal of vegetation on the west bank of the creek, with replacement after the work is completed. Removal of the landfill material would provide room for the creek to be relocated in a naturalized channel without significantly disturbing the east bank. However, a signifiacnt amount of fill would have to be imported to the site to construct the stable slopes, banks and floodplain.

Installation of Purge Wells

The continuous pumping of purge wells installed along the top of the bank in the landfill would reduce the volume of leachate in this area of the landfill. Their continuous operation would also attempt to reduce the flow of leachate eastward that results in seeps from the bank and impact to the creek. However, efficient operation of purge wells within municipal waste is difficult to achieve due to the slow and irregular flow patterns of the leachate. A test well completed in the fall of 1999 indicated that at least 60 to 80 purge wells would be required and that their actual effectiveness may not meet the performance expectations. Based on the recent investigations of the landfill in the area of the slope, the variable nature of the material in the landfill (concrete, wood/logs, waste, fine grain soils) makes it uncertain if the extraction of leachate through vertical wells in the landfill will entirely prevent it from discharging from the bank and entering the creek.

The purge wells would be located within the leachate mound in the landfill and they will extract leachate over the entire length of the screened interval. This would produce a very large volume of leachate that would require treatment. The purge wells would be removing leachate and essentially dewatering portions of the landfill but may not stop the seeps from occurring.

The installation of purge wells does not address bank or creek sediment remediation nor does it provide bank erosion control. Purge wells would be expected to require significant effort to operate and to maintain. Total replacement of each well could be required at least every five years.

Purge Wells with Cut-off Walls

An enhancement to the purge well alternative is to install a "cut-off" wall between the purge wells and the seeps. In this way, the leachate flow would be blocked and collection of the leachate in the wells enhanced. The "cut-off" wall could be installed along the bank of the entire landfill or in specific areas or larger sections where it is found that the purge wells are not preventing leachate seeps. Similar to the purge well alternative, this alternative does not specifically address stream erosion.

The "cut-off" wall would likely be constructed through the injection of a low permeable slurry/grout. This would be accomplished by augering through the waste and connecting the barrier to the underlying silty clay layer. Since large quantities of metal, concrete, wood and other large material have been found in previous work at the landfill, the driving of a barrier through the waste could be unsuccessful and is not considered feasible. Augering to install the slurry wall will also be difficult and it is anticipated that excavation will be required in order to penetrate some areas. The success of the "cut-off" wall will be a function of the installation and the ability to form a waterproof barrier. In addition, waste does exist in the slope of the bank which would be beyond the control of the cutoff walls.

Interceptor Trench and Horizontal Collector Within the Landfill

Similar to installing purge wells, the purpose of a horizontal collector in a trench located within the landfill is to intercept the leachate before it reaches the bank. This alternative will likely be effective at collecting leachate and preventing seeps. However, it is unknown if it can actually be constructed. The depth of the collector must be 8 to 10 metres into waste with a high moisture content. Installation will require significant dewatering of the area and the movement of a large volume of waste. The collector will have the impact of dewatering the landfill and very large volumes of leachate would be collected for treatment.

The health and safety risk for the workers and the community are high with this alternative as a large amount of waste would be exposed during construction. The installation of the trench and collector does not address bank or creek sediment remediation nor does it provide bank erosion control.

Horizontal Collector Adjacent Existing Creek Alignment

This alternative would be constructed by placing a horizontal leachate collector at the toe of the landfill adjacent the existing location of the creek. A ledge would be constructed west of the existing bank into the landfill in order to install the collector. The slope of the bank would be excavated and regraded through the movement of waste. The excavated waste would require disposal at a licensed

off-site facility.

This alternative would be effective in stopping leachate from reaching the creek. However, since the collector would be located within the waste, a direct hydraulic connection would be established and it is anticipated that a very large volume of leachate would be collected. The collector would have the effect of dewatering the landfill. Construction and long-term protection of the collector would be difficult. The collector would have to be installed at an elevation lower than the creek and preventing water from entering the excavation or protecting the slope from damage during high flow events would be difficult. Since a natural channel design is not included in this option, the high stream velocity during storm events may damage the collector system. Over the long term, since bank erosion is not addressed, the area in which the collector is located will be eroded and the system will fail.

This alternative addresses bank remediation because the bank would be excavated. Creek sediment remediation and bank erosion are not addressed with this alternative. The health and safety risks for the workers and the community are high with this alternative as a large amount of waste would be exposed during construction.

Horizontal Collector With Retaining Wall Adjacent Creek

This alternative would be constructed in conjunction with the erosion prevention alternative of a vertical retaining wall on the west bank of the creek. The rationale for not recommending the retaining wall on the west bank of the creek is clearly described in the previous section. The horizontal collector behind the wall would effectively collect the leachate prior to it reaching the creek. Since the face of the waste in the bank will be exposed, a hydraulic connection will be established with the collector which will have the effect of dewatering the landfill.

This alternative addresses all the identified needs except for creek sediment remediation. However, the lifespan of the vertical retaining wall is unknown and downstream impacts will be severe.

Horizontal Collector With Relocated Creek

In conjunction with the erosion prevention alternative of relocating the creek in a naturalized channel, a horizontal leachate collector would also be installed. The collector would be installed under the west bank stage that would be constructed as part of the creek relocation. Leachate would be captured and prevented from entering the creek. The leachate would flow by gravity to a collection area where it would be pumped for appropriate disposal. A liner would be installed below the surficial topsoil on the west bank of the creek to prevent leachate from escaping and to direct it to the collector.

Waste would not be required to be excavated in order to install the collector. Since the face of the waste and existing bank would not be disturbed a direct hydraulic connection with the leachate in the landfill would not be established. The volume of leachate collected would likely be similar to the

volume that is currently flowing to the creek and dewatering of the landfill would not be promoted.

The health and safety risks with this alternative are low as the existing landfill is not impacted. This alternative addresses all of the requirements including bank and creek sediment remediation and erosion prevention.

Evaluation

The "do-nothing" alternative is not acceptable and is eliminated from further consideration. Limiting leachate generation will decrease the volume of leachate within the landfill that can escape to the creek. It will not stop the discharge of leachate to the creek. This alternative should be considered in conjunction with the preferred alternative, as part of the overall landfill management strategy.

Removal of the landfill is not feasible due to timing, community and worker health and safety risks, environmental concerns and extreme cost. It is also eliminated from consideration. The remaining alternatives described in this section all address the prevention of leachate from entering the creek.

Both purge wells and a horizontal collector constructed in the waste material would essentially de-water areas of the landfill through the removal of large volumes of leachate. The effectiveness of purge wells at controlling leachate from escaping from the landfill may be low due to the limitations of vertical wells operating in municipal waste. The construction of a horizontal collection system in the existing landfill or creek bank involves the excavation of a large quantity of waste and will be difficult to construct with significant health and safety concerns. Horizontal collectors in municipal waste are also subject to failure due to plugging and may not entirely prevent flow beneath the collectors and out the lower areas of the bank as seeps.

The preferred bank erosion prevention alternative of constructing a naturalized channel offers an ideal location for placement of a horizontal leachate collection system in the five metre wide west bank stage. This location for the horizontal collector does not require any intrusion into the waste in order to construct it. It will also provide an effective barrier to prevent leachate from reaching the creek. It is expected that the volume of leachate that will be collected will be sufficient to prevent discharge to the creek but not sufficient to cause significant dewatering of the landfill.

5.2.3 Buried Utilities

As discussed in Section 3.6, there are a number of buried utilities at the site which outfall to Red Hill Creek. These buried utilities that cross the landfill have the potential to act as conduits for leachate migration. They were assessed using smoke testing, dye testing and camera survey to determine the flows in the pipes and, to the extent possible, the condition of them. The results of this assessment, and a plan for remedial works related to the buried utilities are summarized in Table 7. All of the storm sewers that cross the landfill will either be abandoned or relocated. The pipes that cross the landfill will be located, plugged and a "cut-off" wall will be placed around the perimeter of the pipe. The "cut-off" wall will prevent migration of leachate through the bedding of the pipe.

Table 7: **Rennie Street Landfill - Buried Utilities Remedial Works Summary Table**

I.D.	Description	Source	Location	Recommended Action
P1	450 mm diameter Corrugated Steel Storm Sewer Outfall	Surface yard drainage from concrete culvert (CUL1) located at Public Works yard. Confirmed by Dye Test	Approximately 50-65 m south of pedestrian bridge. Discharges to creek.	Abandon Sewer, Plug sewer outfall and pipe within works yard and remove from service. Install concrete cut-off wall upstream of bank to control bedding flow. Redirect public works yard surface water drainage away from creek to sewers along Rennie or Brampton Streets. *C of A required for new connection.
P2	450 mm diameter Concrete Storm Sewer Outfall	Yard drainage from Public Works yard. Catch Basin (CB1) buried according to yard foreman. City previously confirmed connection by Dye Test	Just below the top of the bank near MW6-42.	Abandon Sewer, Plug sewer outfall and pipe within works yard and remove from service. Install concrete cut-off wall upstream of bank to control bedding flow. Redirect public works yard drainage away from creek along Rennie or Brampton Streets. *C of A required for new connection.
P3	450 mm diameter Corrugated Steel Storm Sewer Outfall	Suspected to have been connected to former culvert at the Rennie Street entrance to the Public Works yard. Culvert could not be located.	Suspected to extend from landfill near PW-1 at base of bank to culvert (buried?) at Rennie St. entrance to public works yard.	Plug sewer outfall and pipe within works yard and remove from service. Install concrete cut-off wall upstream of bank to control bedding flow. *C of A required for abandonment.
P4	450 mm diameter Corrugated Steel Storm Sewer Outfall.	Rennie St. Storm Sewer connected to Manhole HQ06B035 Confirmed by Dye Test	Base of bank, just above creek level, at end of Rennie Street Road allowance.	Redirect storm line to the existing sanitary interceptor located at the end of Rennie Street within the Public Works Yard. Plug storm sewer and install concrete cut-off wall upstream of bank to control bedding flow. *C of A required for abandonment and new connection.
P5	2.5 cm diameter Plastic Pipes	Suspected to be construction debris.	Through landfill low on bank near seep S4.	Removed as part of local leachate collector installation.

Table 7: Rennie Street Landfill - Buried Utilities Remedial Works Summary Table

I.D.	Description	Source	Location	Recommended Action
P7	600 mm diameter Corrugated Steel Culvert	Provides surface water drainage from valley adjacent to CN rail line, at south end of the Works Yard	Extends from the creek bank at the south end of the site, under the CN rail spur to the valley at the south end of the Works Yard.	No action currently required. Continue to monitor if pipe is within the limits of waste.
P8	6 " Cast Iron Pipe	Suspected to be construction debris. Pipe plugged, no discharge observed	Low on bank approximately 10 metres south of P4	No action currently required. Continue to monitor.
P9	400 mm diameter Storm Sewer	Brampton Street Storm Sewer Outfall Pipe discharges underground into stone spillway Confirmed by Dye Test	Brampton Street R.O.W. below Ontario Hydro Transmission Lines at top of swale covered by stones leading down to the creek	Remove pipe from service except western most catch basin on Brampton Street. Plug pipe from catch basin to sewer outfall (underground) Redirect storm water from west catch basin to the existing sanitary interceptor located near the entrance to the public works yard. *C of A required for abandonment and new connection.

5.3 Preferred Solution

Based on this evaluation, the preferred remedial actions for the site are:

- control leachate generation by placing a low-permeability cover on the landfill and collecting groundwater before it enters the landfill,
- collect leachate that seeps through the bank in a horizontal collector, and
- prevent erosion by expanding the floodplain and relocating the creek away from the landfill in a naturalized channel.

These preferred remedial actions should be effective at controlling discharges to the creek and preventing stream erosion. They can all be readily constructed and will have a long-term lifespan. They offer a cost-effective permanent long-term solution.

The sections that follow describe the three elements of this strategy in more detail.

5.3.1 Control Leachate Generation and Landfill Gas

Since the amount of leachate generated is related to the amount of water that enters the landfill, if the volume of water entering is reduced, the volume of leachate generated will be reduced. Two sources of water into the landfill are groundwater flow and surface water infiltration. To reduce these flows, we propose to place a low-permeability cover on the landfill and to re-grade the area to promote runoff and prevent ponding. Also, a groundwater collector trench to the west of the landfill may be installed to prevent shallow groundwater from entering the landfill. The decision to proceed with this collector will be based on the results of the current investigations that are attempting to quantify the impact of this groundwater on leachate formation.

Landfill gas has been identified in the Public Works Yard. The presence of landfill gas west of the railway spur is thought to be related to the relatively low amount of waste found in the soils at this location. Testing has indicated that landfill gas is not migrating further off-site to the west. Typically, landfill gas will vent through the top of the landfill in covered and uncovered areas and then dissipate into the atmosphere.

The following measures are proposed to address the occurrence of landfill gas in the Public Works Yard:

- all Works Yard buildings and structures will have permanent methane alarms installed (temporary alarms were installed in January 1999 shortly after testing revealed the presence of landfill gas at the site), and

- a landfill gas barrier will be constructed around the western and southern property lines of the Public Works Yard. The barrier wall will be extended south on the west side of the railway line terminating north of CN Rail main line. The landfill gas barrier will consist of a 30 mil high density polyethylene liner installed in a trench excavated to bedrock. A layer of permeable gravel soil will be placed on the landfill side of the barrier, to promote dissipation of any landfill gas to the atmosphere.

5.3.2 Erosion Control

The preferred option is to relocate Red Hill Creek away from the landfill. A new floodplain will be created by widening the creek valley and controlling erosion using natural channel design. Figure 11 shows the conceptual plan for the new floodplain. As indicated, the creek widening extends along the Brampton Street Landfill which is also subject to erosion. A typical cross-section for the new creek is shown on Figure 12.

Since the existing west bank of the creek (slope of the landfill) is steeper than what is considered to be a long term stable slope, the bank must be made less steep be adding clean fill material. At the base of the constructed slope, a bench approximately five metres wide will be constructed. This bank will provide separation between the landfill and the creek. The actual creek channel will be narrowed from its present 16.5 metres width to approximately 13 metres wide, with a corresponding increase in depth of the channel to minimize sediment deposition. Another bank will be constructed on the east side of the creek, 10 to 15 metres wide. The new east slope will be constructed at a stable incline.

Erosion protection measures such as rock veins and cross veins will be installed to control the stream energy in key areas. Between 100,000 and 150,000 cubic metres of material will be moved from the area on the east side of the creek in order to construct the naturalized channel. A large portion of this material will be used to construct the required banks and slopes and also it may be used for grading and contouring on top of the landfill. Once the excavation has been completed and the creek relocated, the area will be revegetated with native plant species consistent with the Red Hill Creek Watershed Plan.

In order to complete the work, the pedestrian bridge at the north end of the landfill will be lengthened and the buried steam line between the SWARU and the Sewage Treatment Plant will be modified to accommodate the construction.

5.3.3 Collect Leachate

When the creek is relocated to the east in the naturalized channel, the five metre wide bench on the west side of the creek will be used to locate a horizontal leachate collection system. The west slope adjacent the landfill will be covered with an impermeable material. Any leachate that reaches the slope will flow downwards behind the cover, to the collector which will then carry it to a central area

where it will be pumped for disposal. The collector and barrier will be designed such that any leachate escaping from the landfill will be captured, but not to promote the dewatering of the landfill.

Currently, the seeps are grouped together with a number of isolated seeps between the groups. The flow from the seeps is relatively low. As discussed in Section 5.1, to prevent leachate from entering the creek between now and when the creek is re-located, it is proposed to install localized collector trenches directly into the seeps at two to four locations along the west bank. Such collectors have been demonstrated to intercept most, but not all, of the seepage at the locations where they are installed.

5.4 Implementation Plan

The remedial works will be implemented in accordance with the following schedule:

Action	Schedule
Construct localized collectors into the west bank of the creek:	
– at seeps S4-S20 at the south end of the site – at seep S19 at the north end of the site	June 2000 July 2000
Evaluate the effectiveness of these trenches and extend to other seep areas, if effective	June – October 2000
Confirm the feasibility of installing a groundwater cut-off trench on the west side of the landfill	June – October 2000
Design and install low-permeability cover	June – December 2000
Re-locate buried utilities through Rennie Street Landfill and plug and cut off existing pipes where possible	June – September 2000
If feasible, install temporary erosion protection in creek	June – September 2000
Install passive gas barrier	November – December 2000
Expand floodplain and relocate the creek: – complete the design and Environmental Assessment – construction	 June – December 2000 Contingent Upon Approvals

5.5 Public Consultation

A Public Consultation Session was held from 6:00 p.m. to 10:00 p.m. on Thursday, June 1, 2000 at the Woodward Avenue Public School, 575 Woodward Avenue, Hamilton, Ontario. The purpose of the session was to meet with the public, discuss the landfill site conditions and proposed remedial

works and receive feedback from interested parties. Specifically, the following items were presented for discussion and comment:

- the nature of the problem,
- the proposed strategy,
- elevation of remedial alternatives,
- the proposed floodplain expansion and creek relocation, and
- implementation plan for the remedial works.

Notices of the Public Consultation Session were placed in the Hamilton Spectator on May 19th and 26th, 2000. Agencies and parties on the project mailing list were notified of the meeting via telephone and/or E-mail during the two weeks prior to the meeting. Residents on Waterloo Street and the adjacent businesses on Rennie Street were hand delivered a copy of the notice of the Public Consultation Session on May 30, 2000.

It is estimated that 45 to 50 members of the general public attended the Public Consultation Session, although only 43 people registered their attendance .

Display boards were presented which provided information on the project background, site conditions and the problem, alternative ways to manage the problem, the proposed strategy including the creek relocation, and the implementation plan. A copy of the display boards is included in Appendix L.

The following people were in attendance to discuss the project with interested parties:

- Bill Allison - Dillon Consulting Limited
- Bill Annable - Water Regime, Investigations and Simulations Limited
- Laurie Bruce - Dillon Consulting Limited
- Ray Carter - Dillon Consulting Limited
- George Coker - C. Portt and Associates
- Patsy Duever - Dillon Consulting Limited
- Peter Dunn - Region of Hamilton-Wentworth, Waste Management Department
- Charlie Guthro - City of Hamilton, Public Works
- Rob Hall - Regional Health Department
- Ian Judd-Henry - Dillon Consulting Limited
- Reg Meiers - City of Hamilton, Public Works
- Karen St. Aubin - Region of Hamilton-Wentworth, Waste Management Department
- Tim Tuck - City Of Hamilton, Communications
- Ken Ursic - Dougan and Associates
- Ron Weiss - Dillon Consulting Limited

The atmosphere of the Public Consultation Session was intended to promote dialogue. Attendees were welcomed at the entrance and invited to register their attendance and to review the displays and to feel free to discuss any matters with available staff. At the request of some local residents a formal question and answer period was held.

Comment sheets were provided to all attendees in order to document their comments and concerns. Written comments were provided by ten attendees and are summarized as follows:

- remove the landfill (4 comments),
- caution to make sure that "long-term" is indeed long-term (1 comment),
- concern with cancer incidence on Waterloo Street (1 comment),
- focus on the slope stability and ensure cost-effective use of funds (1 comment), and
- support for the plan presented (1 comment).

Two of the comment forms have not been summarized due to foul and abusive language.

Public consultation on the project will be on-going as the works proceed.

6.0 LIMITATIONS

The report was prepared exclusively for the purposes, project and site location outlined in the report. The report is based on information provided to, or obtained by Dillon as indicated in the report, and applies solely to site conditions existing at the time of the site investigation(s). Although a thorough investigation was conducted by Dillon, it is possible that currently unrecognized contamination or potentially hazardous materials may exist at the site, and that the levels of contamination or hazardous materials may vary across the site.

The report was prepared by Dillon for the sole benefit of the City of Hamilton. The material in it reflects Dillon's best professional judgement in light of the information available to it at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions made based on it, are the responsibilities of such third parties. Dillon accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

7.0 REFERENCES

Chapman, L.J. and Putman, D.F., 1984, The Physiography of Southern Ontario, 3rd edition, Ministry of Natural Resources, Ontario geological Survey, Special Volume 2, 270p.

Conestoga-Rovers & Associates, Brampton Street Landfill Investigation Final Report Mountain East-West and North-South Transportation Corridor, April 1990.

Dillon Consulting Limited, Rennie Street Landfill Environmental Investigations and Pre-Design, March 2000.

Feenstra, B.H., 1975, Quaternary Geology of the Grimsby Area, Southern Ontario; Ontario Division of Mines, Preliminary Map P993, Geological Services, scale 1:50,000.

Golder Associates Ltd., Geotechnical Infill Programme North-South Parkway Hamilton-Wentworth Ontario, Golder Report No. 881-1416-1, March 1989.

Golder Associates Ltd., Geotechnical Investigation Rennie Street Landfill North-South Parkway, Golder Report No. 881-1416-A, March 1989.

Jagger Hims Limited, Leachate Management System Assessment former Brampton Street Landfill, October 1994.

Mackay, D., Wan Ying Shiu and Kuo Ching Ma, 1992, Illustrated Handbook of Physical-Chemical Properties and Environmental Fate For Organic Chemicals, Volume 1; Monoaromatic Hydrocarbons, Chlorobenzenes and PCBs, 697p.

Ministry of the Environment (MOE), 1996 (revised Feb. 1997), Guideline for Use at Contaminated Sites in Ontario.

Ministry of the Environment (MOE), last revised July 1994, Water Management: Policies, Guidelines, Provincial Water Quality Guidelines.

Morrison Beatty Limited, Hydrogeological Assessment of Brampton Street Landfill Site Region of Hamilton-Wentworth, December 1990.

Ontario Geological Survey (OGS), 1991, Bedrock Geology of Ontario, southern sheet, Ontario Geological Survey, Map 2544, scale 1:1,000,000.

Procter & Redfern Limited, Development of a Comprehensive Environmental Monitoring Program for the Open and Closed Landfill Sites Within Regional Jurisdiction, January 1994.

Regional Municipality of Hamilton-Wentworth Regional Environment Department, Report to Environmental Services Committee on Remedial Action Program: Closed Landfill Sites (ENV 996-094), September 23, 1996.

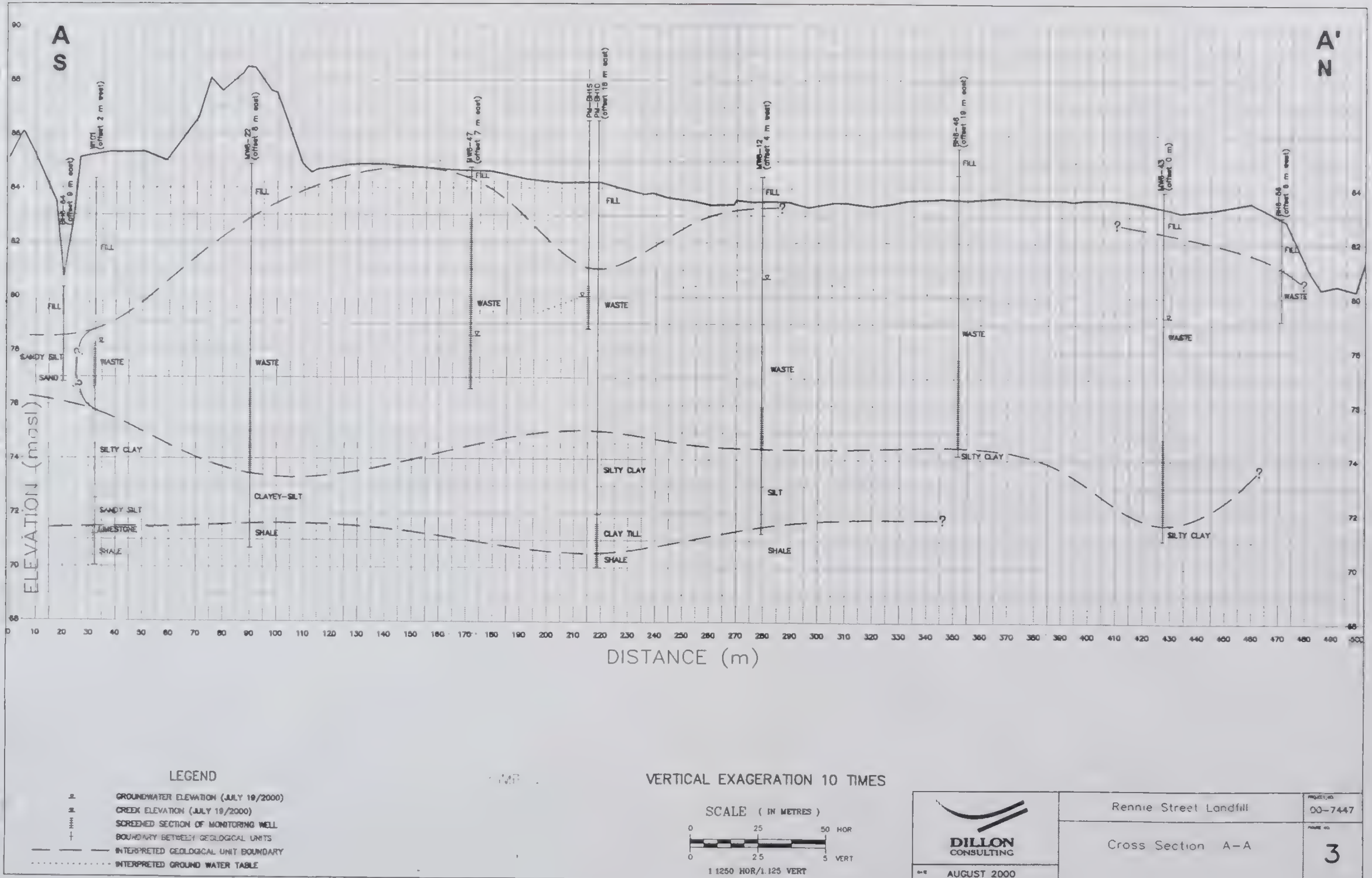
Regional Municipality of Hamilton-Wentworth, 1989, Sewer Use By-Law R89-049.

NTS

FORMER RENNIE STREET LANDFILL

DILLON

SITE LOCATION PLAN	AUGUST 2000	FIGURE 1



A
S
A'
N
BH8-54 (offset 0 m east)
W101 (offset 2 m west)
MW8-22 (offset 8 m east)
MW8-47 (offset 7 m east)
PW-BH15
PW-BH10 (offset 18 m east)
MW8-12 (offset 4 m west)
BH8-46 (offset 10 m east)
MW8-43 (offset 0 m)
BH8-56 (offset 8 m west)
FILL
WASTE
SANDY SILT
SAND
SILTY CLAY
CLAYEY-SILT
LIMESTONE
SHALE
CLAY TILL
SILT
ELEVATION (masl)
DISTANCE (m)
LEGEND
GROUNDWATER ELEVATION (JULY 19/2000)
CREEK ELEVATION (JULY 19/2000)
SCREENED SECTION OF MONITORING WELL
BOUNDARY BETWEEN GEOLOGICAL UNITS
INTERPRETED GEOLOGICAL UNIT BOUNDARY
INTERPRETED GROUND WATER TABLE
VERTICAL EXAGERATION 10 TIMES
SCALE (IN METRES)
50 HOR
5 VERT
1:1250 HOR/1:125 VERT
DILLON CONSULTING
AUGUST 2000
Rennie Street Landfill
Cross Section A-A
00-7447
3

LEGEND

BOREHOLE	SEDIMENT SAMPLING LOCATION
MONITORING WELL	SURFACE WATER SAMPLING LOCATION
PUMPING WELL	SEEPAGE METER
TEST PIT	OUTFALL
SOIL GAS WELL	

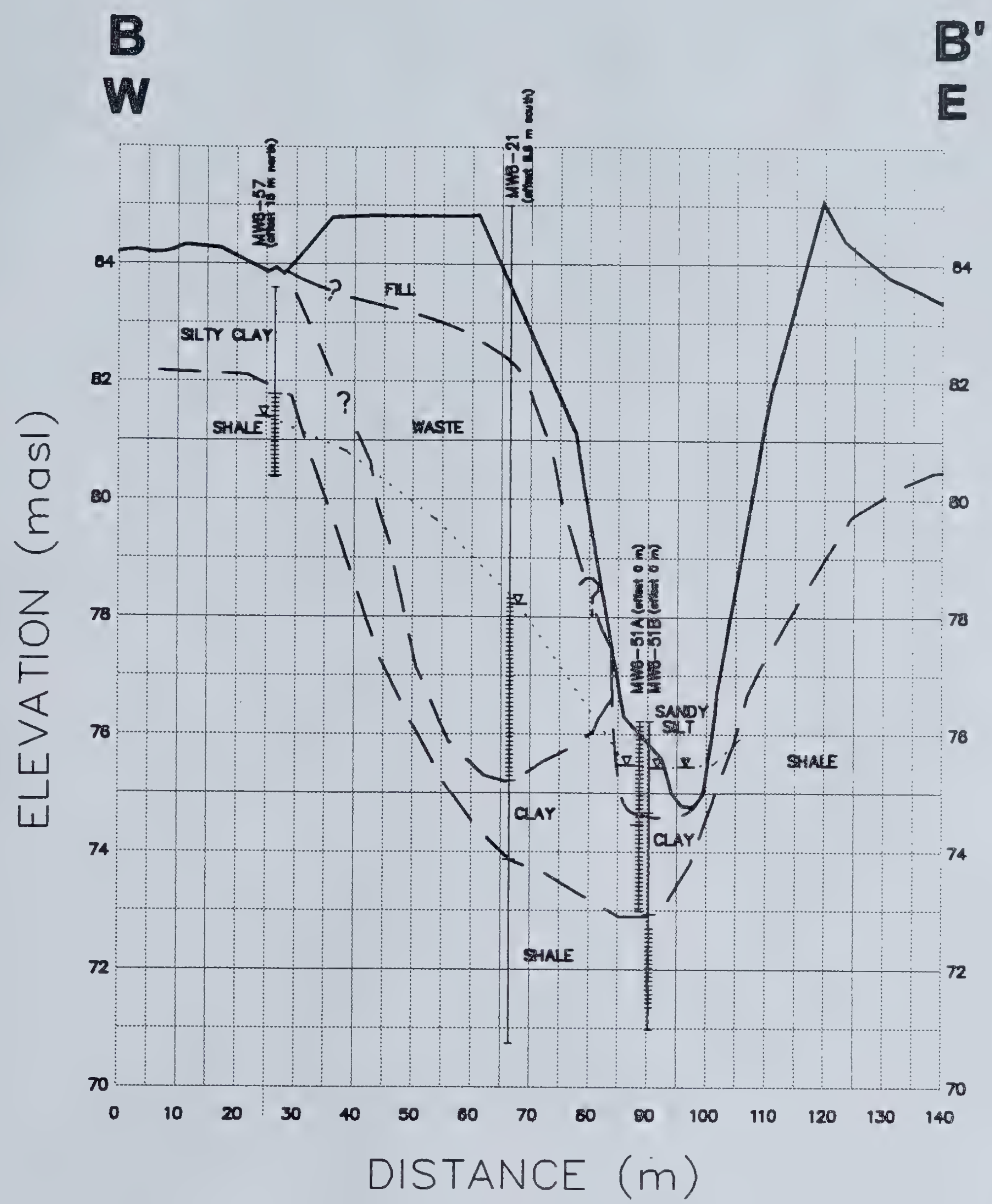
A A' SECTION LOCATION

SCALE 0 50m

SCALE 1:1200

DILLON CONSULTING	SITE PLAN	PROJECT NO. 00-7447
DATE AUGUST 2000	FORMER RENNIE STREET LANDFILL INVESTIGATION	FIGURE NO. 2

G:/CAD/007447/MISC FIGURES/FIGURE.DWG, PLOT 1=1, PAPER SPACE



LEGEND

▽	GROUNDWATER ELEVATION (JULY 19/2000)
▼	CREEK ELEVATION (JULY 19/2000)
	SCREENED SECTION OF MONITORING WELL
+	BOUNDARY BETWEEN GEOLOGICAL UNITS
— — —	INTERPRETED GEOLOGICAL UNIT BOUNDARY
· · · · · · ·	INTERPRETED GROUND WATER TABLE

VERTICAL EXAGERATION 10 TIMES

SCALE (IN METRES)

0 25 50 HOR

0 2.5 5 VERT

1:1250 HOR/1:125 VERT

DILLON CONSULTING

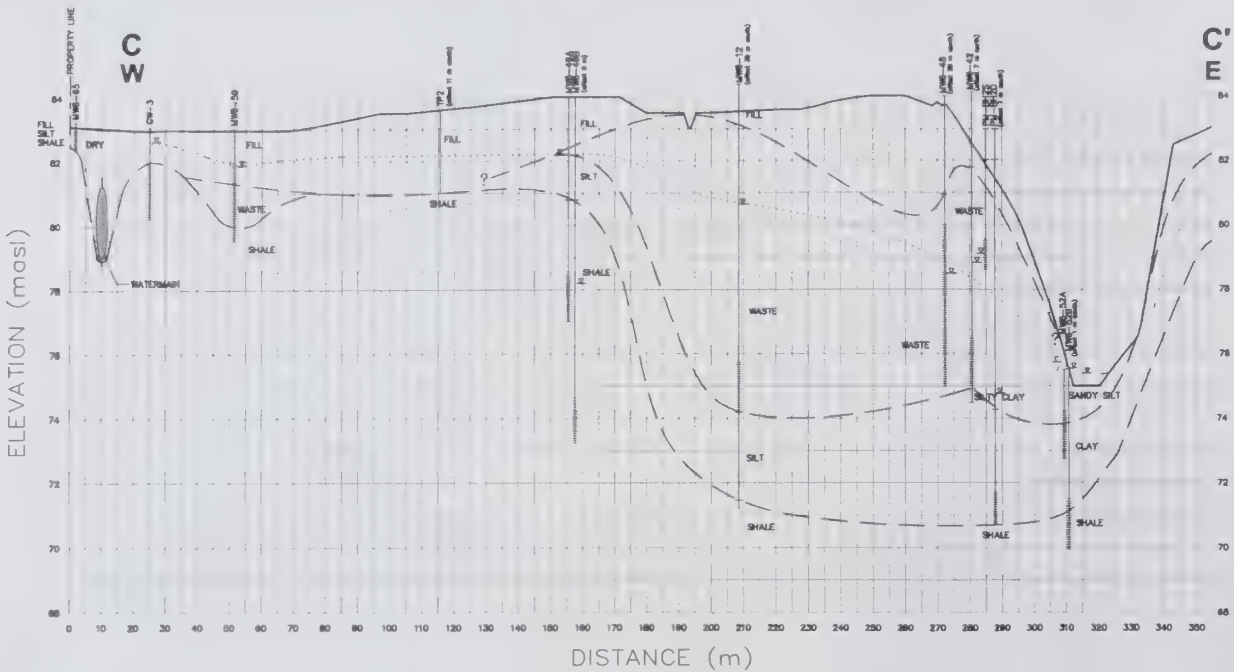
Rennie Street Landfill

Croos Section B-B

PROJECT NO. 007447

FIGURE NO. 4

DATE AUGUST 2000



LEGEND

- GROUNDWATER ELEVATION (JULY 19/2000)
- CREEK ELEVATION (JULY 19/2000)
- SCREENED SECTION OF MONITORING WELL
- BOUNDARY BETWEEN GEOLOGICAL UNITS
- INTERPRETED GEOLOGICAL UNIT BOUNDARY
- INTERPRETED GROUND WATER TABLE
- WATERMAIN (90")

VERTICAL EXAGERATION 10 TIMES

SCALE (IN METRES)

0 25 50 HOR

0 2.5 5 VERT

1:1250 HOR/1:125 VERT

DILLON CONSULTING

AUGUST 2000

Rennie Street Landfill

00-7447

Cross Section C-C

5

LEGEND

- GROUNDWATER ELEVATION (JULY 19/2000)
- CREEK ELEVATION (JULY 19/2000)
- SCREENED SECTION OF MONITORING WELL
- BOUNDARY BETWEEN GEOLOGICAL UNITS
- INTERPRETED GEOLOGICAL UNIT BOUNDARY
- INTERPRETED GROUND WATER TABLE
- WATERMAIN (90")

VERTICAL EXAGERATION 10 TIMES

SCALE (IN METRES)

0 25 50 HOR

0 2.5 5 VERT

1:1250 HOR/1:125 VERT

DILLON CONSULTING

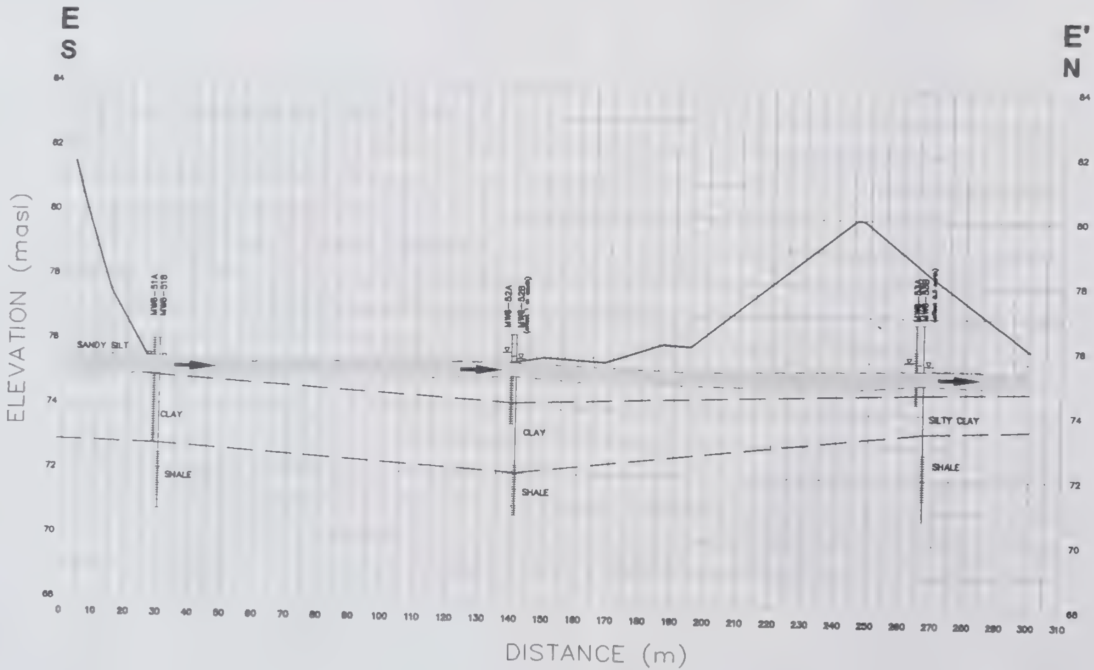
AUGUST 2000

Rennie Street Landfill

Cross Section D-D

00-7447

6



LEGEND

- GROUNDWATER ELEVATION (JULY 19/2000)
- CREEK ELEVATION (JULY 19/2000)
- SCREENED SECTION OF MONITORING WELL
- BOUNDARY BETWEEN GEOLOGICAL UNITS
- INTERPRETED GEOLOGICAL UNIT BOUNDARY
- INTERPRETED GROUND WATER TABLE
- STREAM FLOW
- CREEK

VERTICAL EXAGERATION 10 TIMES

SCALE (IN METRES)

0 25 50 HOR

0 2.5 5 VERT

1:1250 HOR/1:125 VERT

DILLON CONSULTING

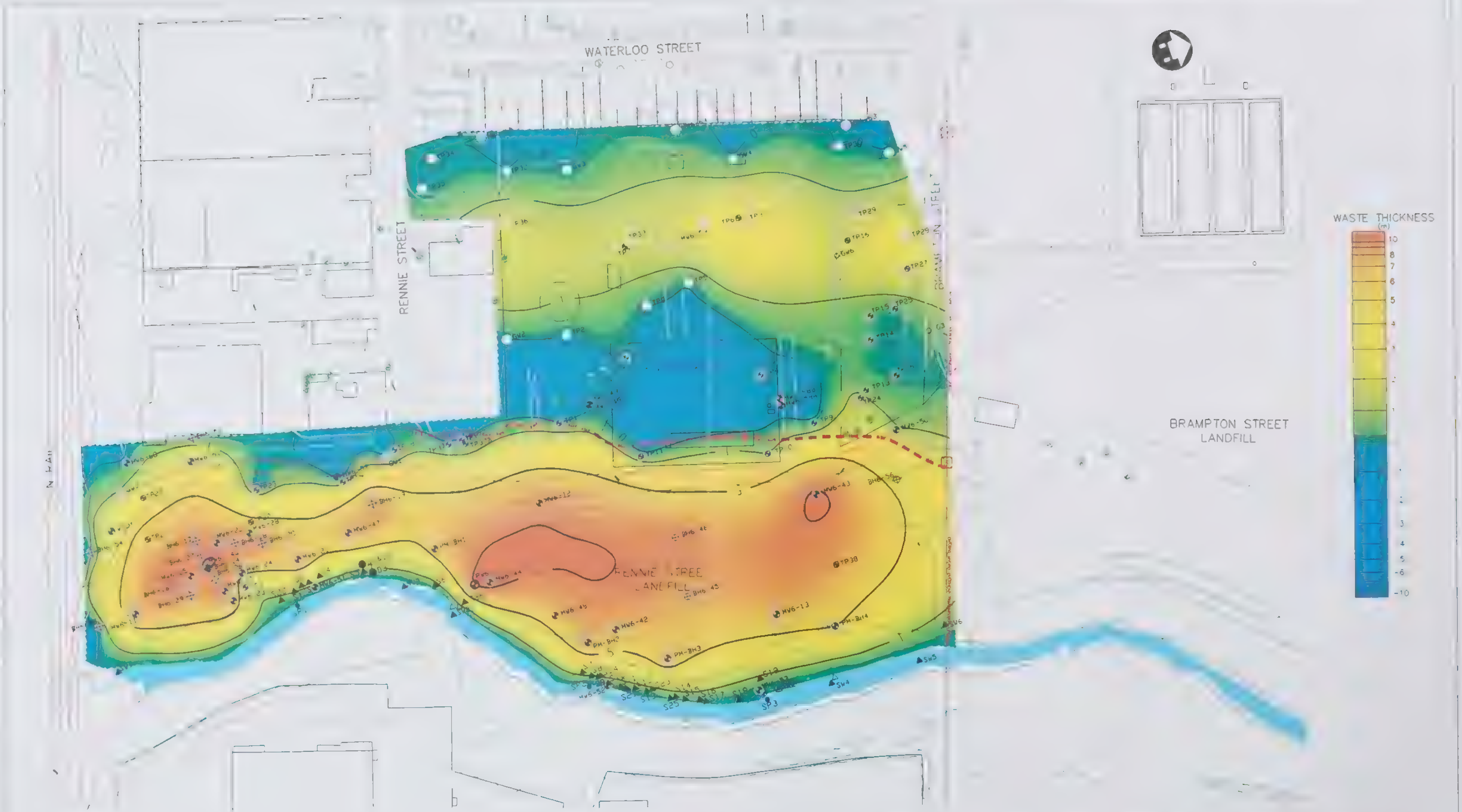
AUGUST 2000

Rennie Street Landfill

Cross Section E–E

00-

7



LEGEND

TOP OF FORMER BANK
INTERPRETED WASTE THICKNESS (M)
CONTOURED DATA POINT

SCALE
0 50 100
(IN METRES)
1:2000

DILLON CONSULTING

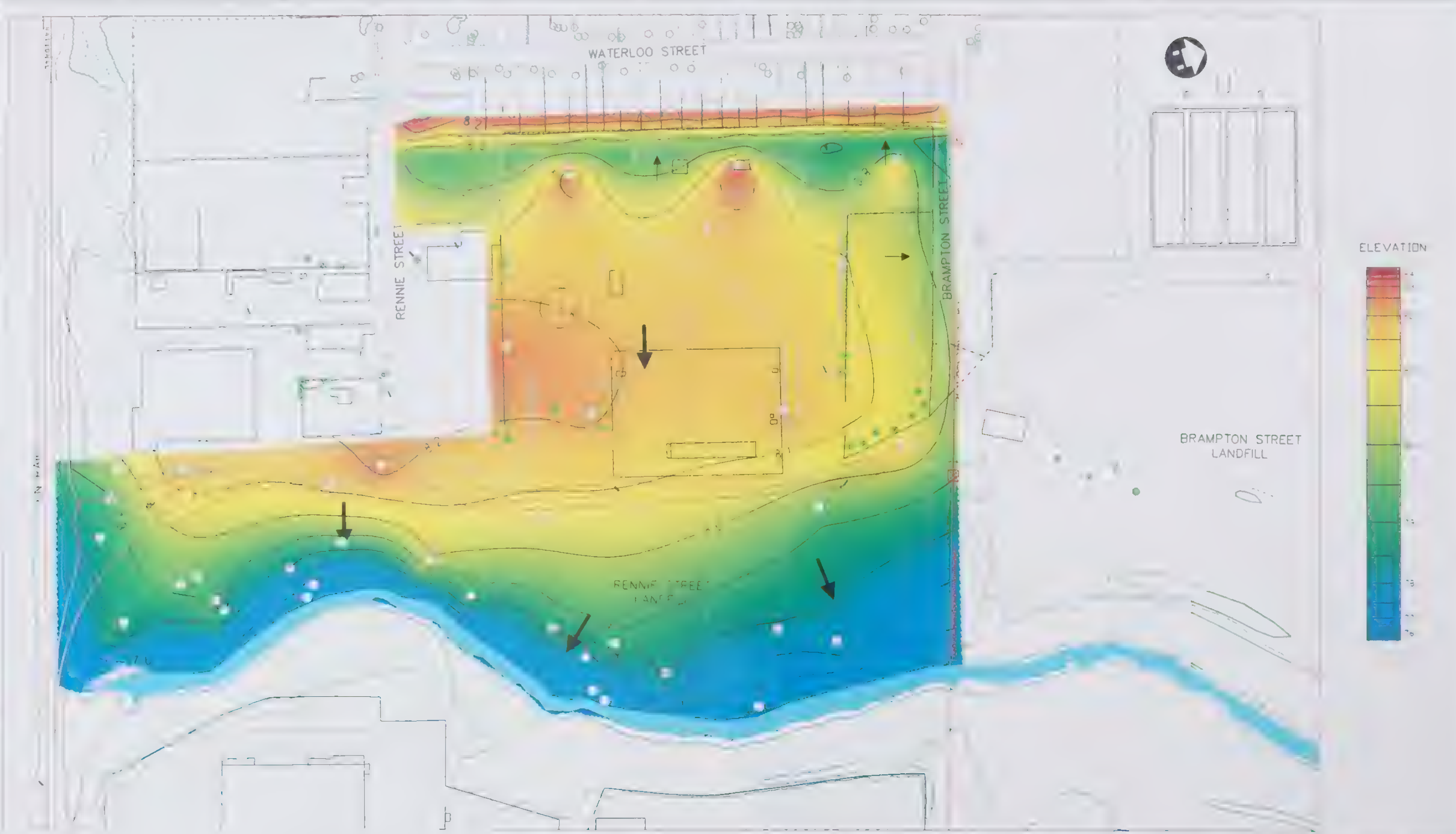
DATE AUGUST 2000

WASTE THICKNESS

RENNIE STREET LANDFILL
ENVIRONMENTAL INVESTIGATION

PROJECT NO. 00-7447

FIGURE NO. 8



DILLON CONSULTING

DATE AUGUST 2000

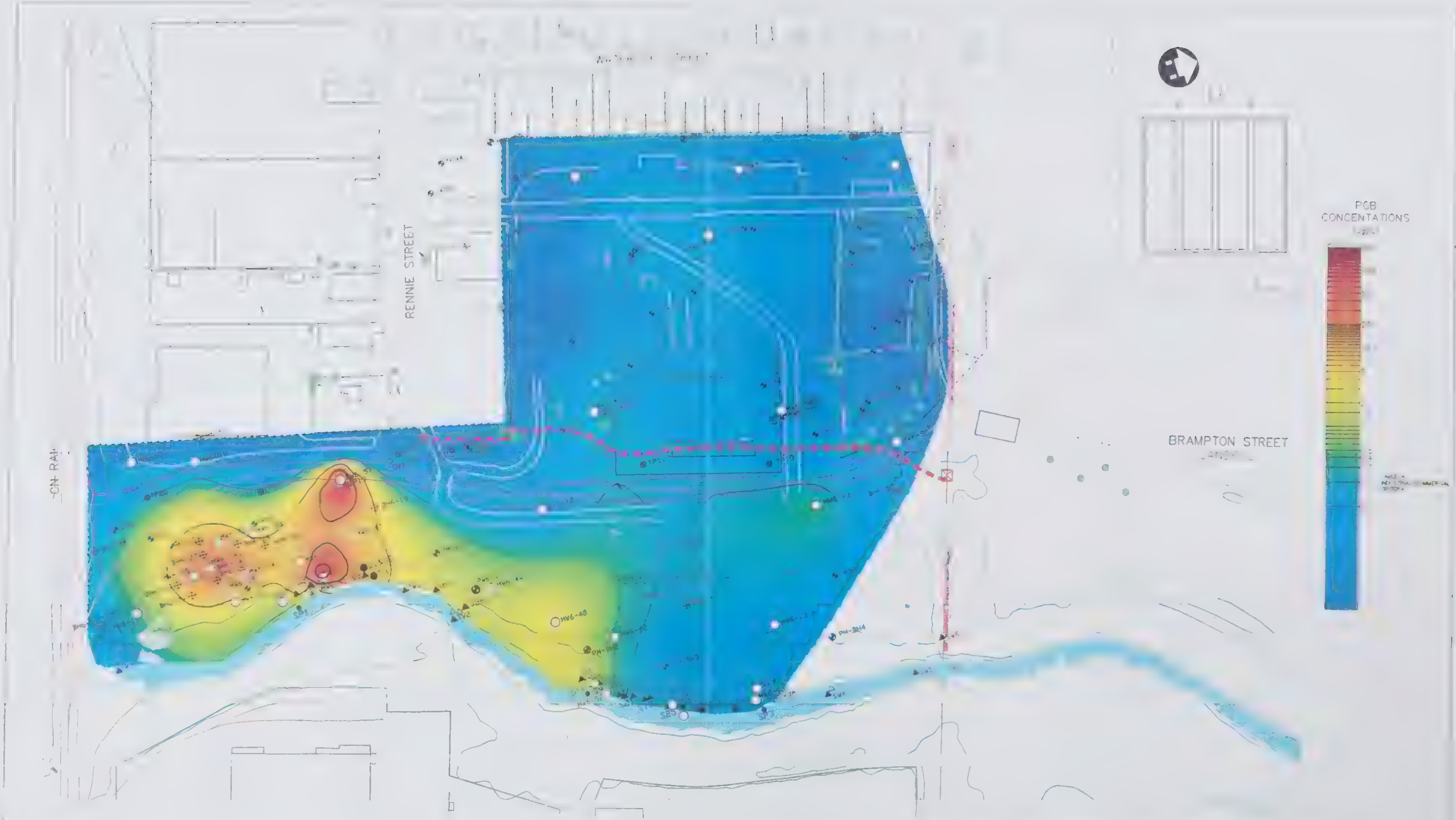
GROUNDWATER ELEVATIONS

RENNIE STREET LANDFILL ENVIRONMENTAL INVESTIGATION

PROJECT NO. 00-7447

FIGURE NO. 9

G:\CAD\00744 Misc Figures\figure9.dwg Mon Aug 28 13:41:30 2000



LEGEND

TOP OF FORMER BANK

INTERPRETED PCB CONCENTRATIONS (ug/L)

SCALE

100

(IN METRES)
1:2000

DILLON CONSULTING

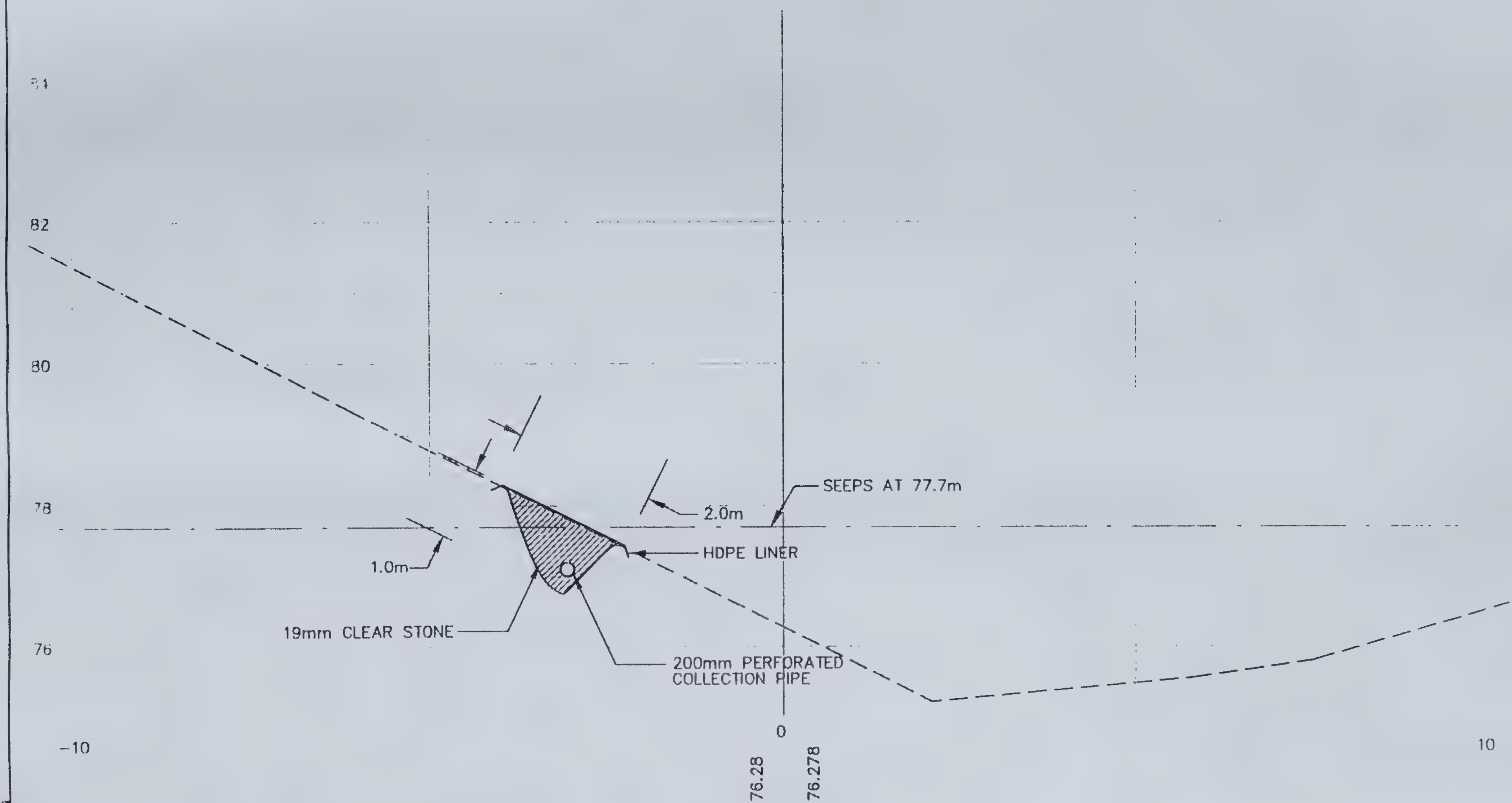
DATE AUGUST 2000

PCB CONCENTRATIONS IN LEACHATE

PROJECT NO. 00-7447

RENNIE STREET LANDFILL
ENVIRONMENTAL INVESTIGATION

FIGURE NO 10



DILLON CONSULTING

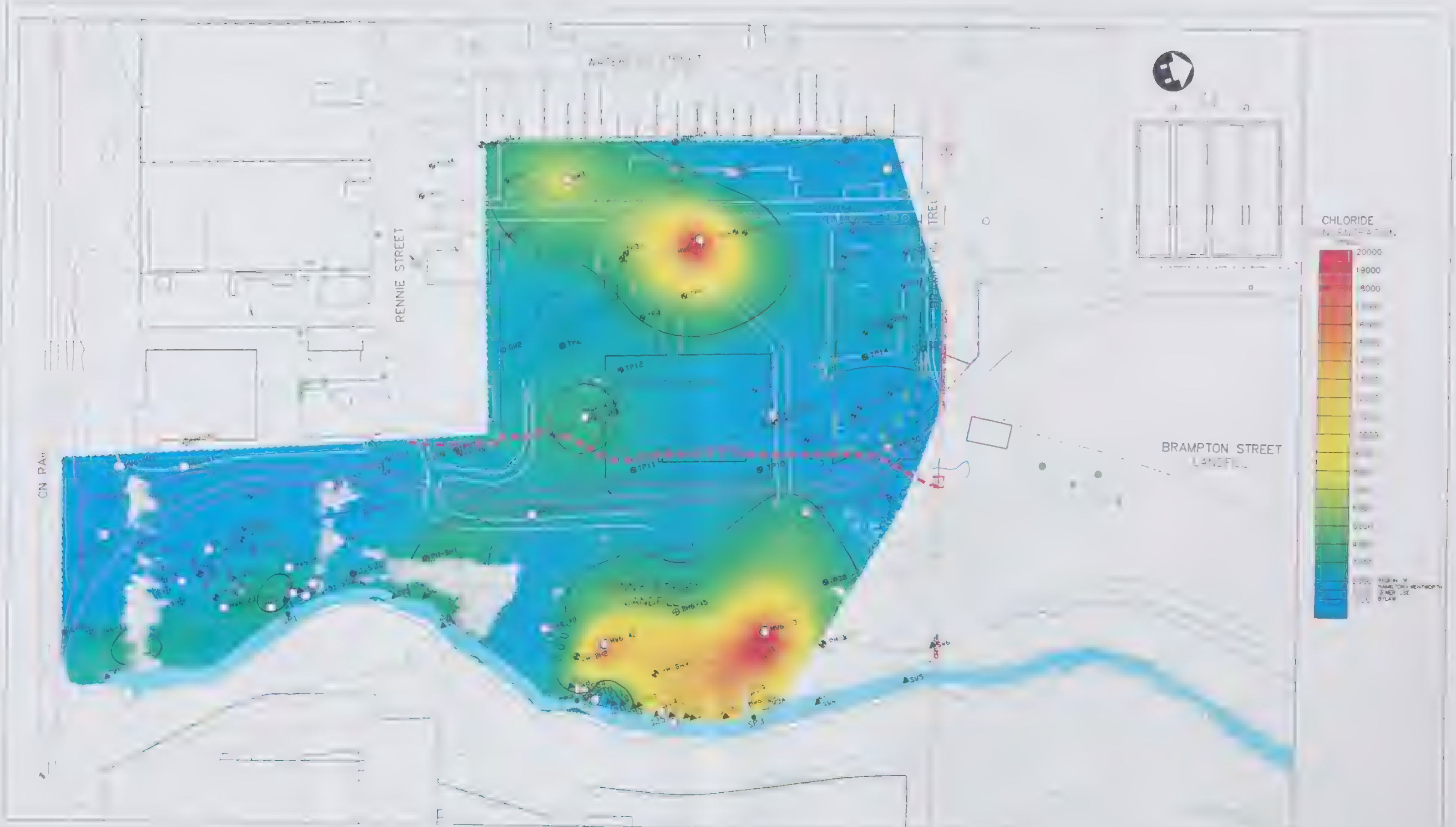
DATE AUGUST 2000

CONCEPTUAL DESIGN - LOCAL LEACHATE COLLECTION SYSTEM

RENNIE STREET LANDFILL

PROJECT NO. 00-7447

FIGURE NO. 12



LEGEND

TOP OF FORMER BANK

INTERPRETED CHLORIDE CONCENTRATIONS (mg/L)

CONTOURED DATA POINT

SCALE

0 50 100

(IN METRES)

1:2000

DILLON

DATE AUGUST 2000

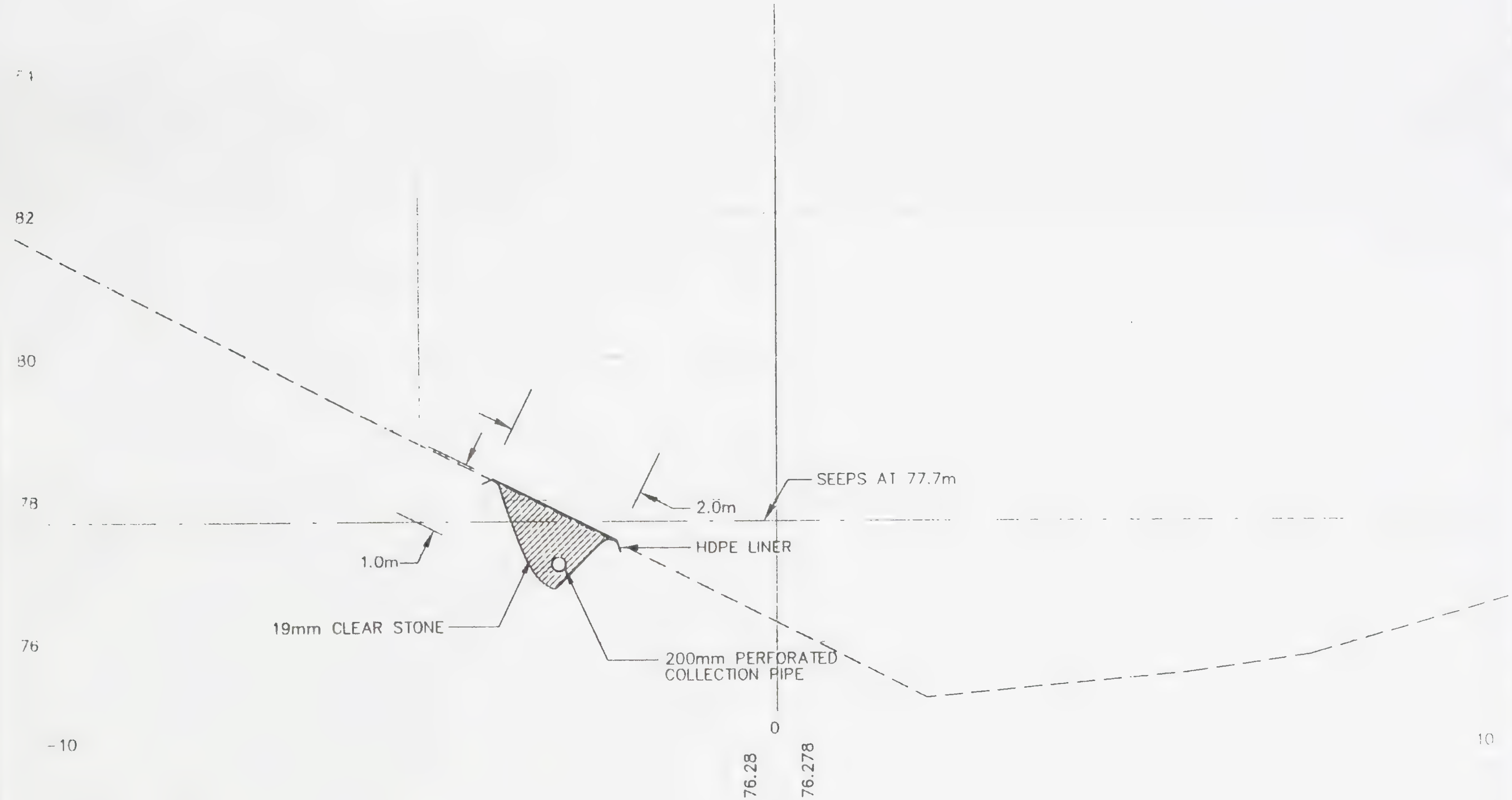
CHLORIDE CONCENTRATION IN LEACHATE

RENNIE STREET LANDFILL
ENVIRONMENTAL INVESTIGATION

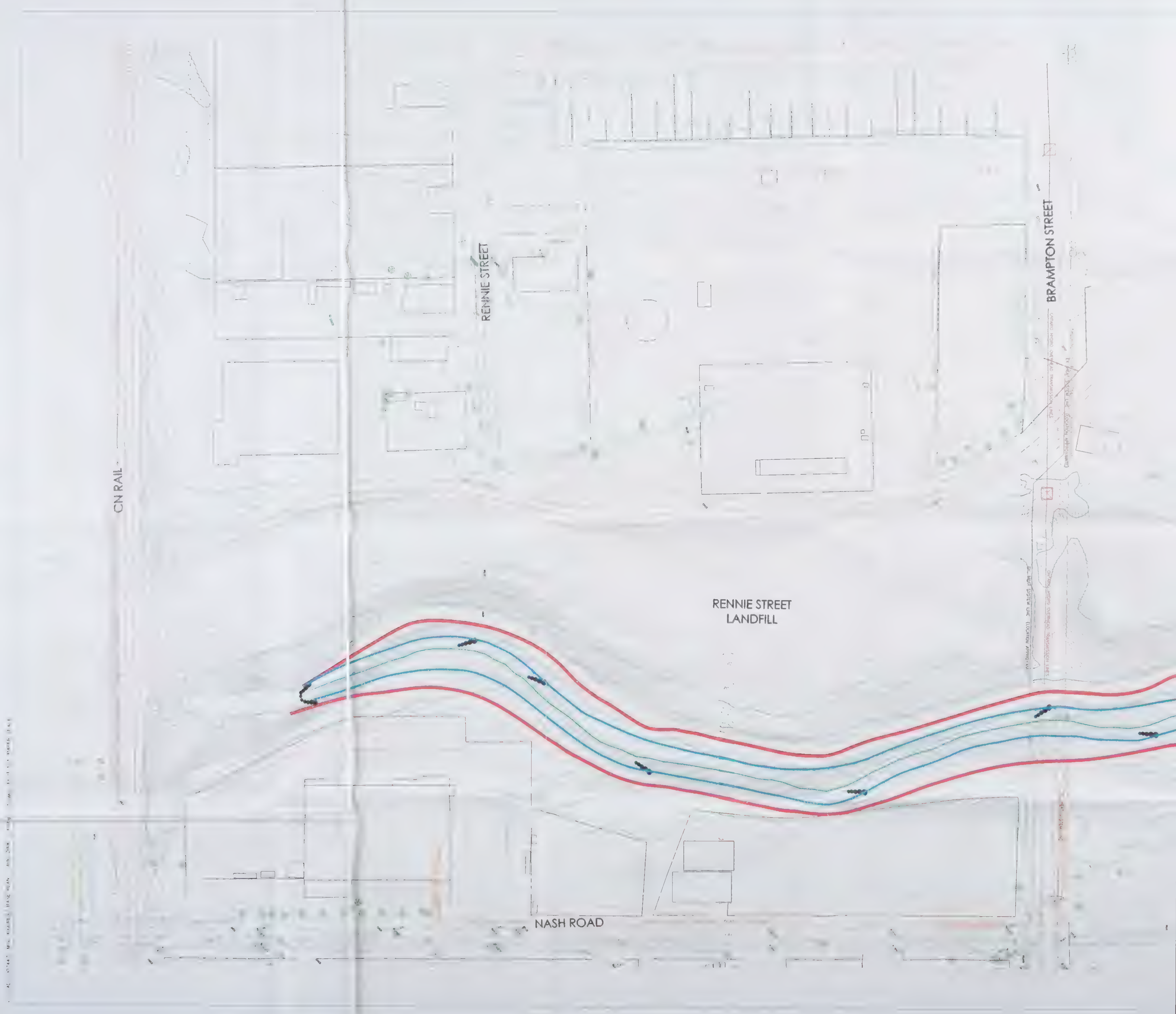
PROJECT NO.
00-7447

FIGURE NO.
11

G:\CAD\00 ... Misc Figures\figure11.dwg Mon Aug 28 12:25:02 2000

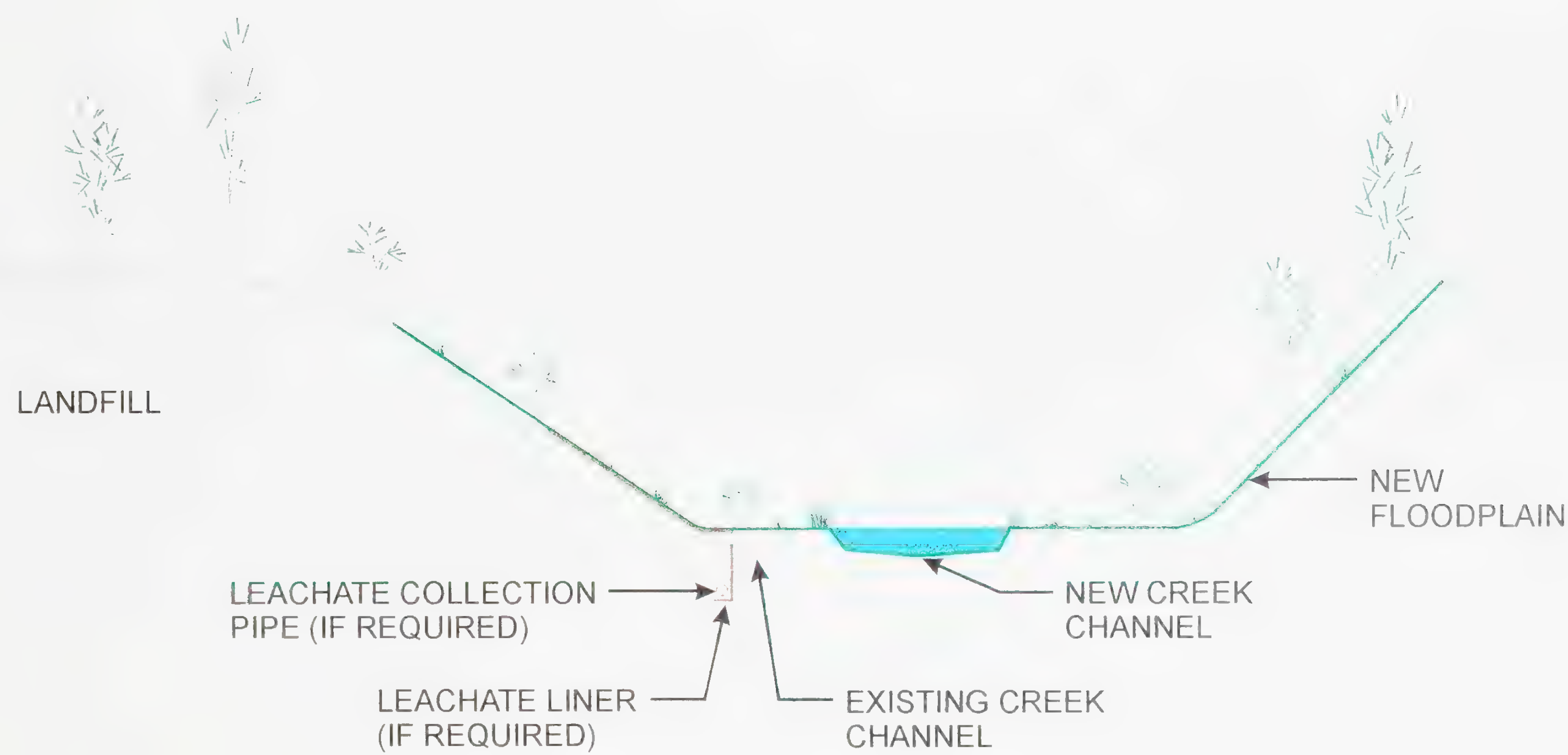


DILLON CONSULTING	CONCEPTUAL DESIGN - LOCAL LEACHATE COLLECTION SYSTEM		PROJECT NO. 00-7447
DATE AUGUST 2000	RENNIE STREET LANDFILL		FIGURE NO. 12



CN RAIL
RENNIE STREET
BRAMPTON STREET
RENNIE STREET
LANDFILL
NASH ROAD


BRAMPTON STREET
LANDFILL
Stream Restoration Legend
Rock Vein
Cross Vein
Limits of Bankfull Flood Plain Elevation
Limits of Bankfull Channel
Limits of Bankfull Channel
Scale (metres)
0 25 50 75 100
DILLON
CONSULTING
PLAN FOR WIDENING OF FLOODPLAIN
PROJECT NO.
00-7447
FORMER RENNIE STREET LANDFILL
FIGURE NO.
13
DATE
AUGUST 2000



DILLON

DATE AUGUST 2000

TYPICAL CROSS SECTION OF NEW CREEK

FORMER RENNIE STREET LANDFILL

PROJECT NO 00-7447

FIGURE NO. 14

APPENDIX A

Test Pit and Borehole Logs

TABLE A-1
BOREHOLE AND MONITORING WELL CONSTRUCTION DETAILS

Borehole No.	Date of Drilling/ Installation	Ground Surface Elevation (m.a.s.l.)	Monitoring Well Installed	Borehole Depth (m)	Open Interval (m.b.g.s.)		Screen Interval (m.b.g.s.)		Stick-Up\Down	Screen Length (m)	Well Dia. (m)
					Bottom	Top	Bottom	Top			
6-11	22/09/97	84.58	Y	13.11	8.53	5.49	8.23	6.71	+0.80	1.52	0.051
6-12	23/09/97	84.38	Y	13.11	10.21	4.58	10.10	8.58	+0.78	1.52	0.051
6-13	23/09/97	83.01	Y	12.18	9.45	7.46	9.15	7.63	+0.82	1.52	0.051
6-14	24/09/97	84.98	N	13.87	-	-	-	-	-	-	-
6-14a	20/10/97	84.95	Y	12.80	12.80	10.00	12.19	10.67	+0.67	1.52	0.051
6-15	20/10/97	84.94	Y	12.80	12.80	10.10	12.19	10.67	+0.82	1.52	0.051
6-16	20/10/97	84.92	N	12.80	-	-	-	-	-	-	-
6-17	20/10/97	84.75	N	11.28	-	-	-	-	-	-	-
6-18	20/10/97	84.86	N	11.28	-	-	-	-	-	-	-
6-19	20/10/97	84.63	N	11.13	-	-	-	-	-	-	-
6-21	28/04/98	85.04	Y	12.04	9.8	6.1	9.8	6.75	+0.73	3.05	0.051
6-22	27/04/98	84.76	Y	12.04	11.3	7.2	11.3	8.25	+0.73	3.05	0.051
6-23	27/04/98	84.83	Y	14.02	10.75	6.8	10.75	7.7	+0.82	3.05	0.051
6-24	23/04/98	84.90	Y	10.52	9.8	5.8	9.8	6.75	+0.74	3.05	0.051
6-25	23/04/98	84.80	Y	10.50	9.9	6.0	9.9	6.9	+0.77	3.05	0.051
6-26	24/04/98	84.89	N	11.28	-	-	-	-	-	-	-
6-27	27/04/98	84.83	N	11.28	-	-	-	-	-	-	-
6-28	23/04/98	84.86	Y	10.37	9.8	5.8	9.8	6.8	+0.68	3.05	0.051
6-29	24/04/98	84.78	N	12.04	-	-	-	-	-	-	-

TABLE A-1
BOREHOLE AND MONITORING WELL CONSTRUCTION DETAILS

Borehole No.	Date of Drilling/ Installation	Ground Surface Elevation (m.a.s.l.)	Monitoring Well Installed	Borehole Depth (m)	Open Interval (m.b.g.s.)		Screen Interval (m.b.g.s.)		Stick-Up\Down	Screen Length (m)	Well Dia. (m)
					Bottom	Top	Bottom	Top			
6-42	10/10/98	84.09	Y	9.75	9.1	6.1	9.1	7.6	0.93	1.5	0.051
6-43	10/10/98	93.82	Y	12.8	12.2	5.5	12.2	9.1	0.8	3.05	0.051
6-44	10/10/98	87.16	Y	16.77	16.8	12.2	16.8	13.7	-0.08	3.05	0.051
6-45	10/10/98	84.12	N	9.75	-	-	-	-	-	-	-
6-46	10/10/98	84.78	N	11.28	-	-	-	-	-	-	-
6-47	01/05/00	84.83	Y	8.23	8.23	1.83	8.23	2.13	0.8	6.09	0.051
6-48	01/05/00	87.091	Y	12.2	11.8	5.2	11.8	5.8	0.75	6.09	0.051
6-49A	02/05/00	84.335	Y	7.6	7.6	4.27	7.6	4.6	0.82	3.05	0.051
6-49B	02/05/00	84.335	Y	10.82	10.82	8.84	10.82	9.29	0.71	1.5	0.04
6-50	03/05/00	83.207	Y	6.09	6.09	2.45	6.09	3.05	0.51	3.05	0.051
6-51A	10/05/00	76.217	Y	3.2	3.2	0.15	3.2	0.15	0.75	3.05	0.04
6-51B	10/05/00	76.028	Y	5.18	5.08	3.55	5.08	3.55	1.05	1.5	0.04
6-52A	09/05/00	75.333	Y	2.28	2.28	0.762	2.28	0.762	0.96	1.5	0.04
6-52B	09/05/00	75.333	Y	5.39	5.39	3.86	5.39	3.86	3.86	0.91	1.5
6-53A	10/05/00	76.042	Y	2.36	2.36	0.83	2.36	0.83	0.76	1.5	0.04
6-53B	10/05/00	76.042	Y	6.09	6.09	4.57	6.09	4.57	0.80	1.5	0.04
6-54	11/05/00	80.2	N	3.35	-	-	-	-	-	-	-
6-55	11/05/00	83.016	N	2.67	-	-	-	-	-	-	-
6-56	11/05/00	82.943	N	3.73	-	-	-	-	-	-	-
6-57	11/05/00	83.56	Y	3.20	3.20	1.6	3.20	1.6	1.03	1.5	0.04

TABLE A-1
BOREHOLE AND MONITORING WELL CONSTRUCTION DETAILS

Borehole No.	Date of Drilling/ Installation	Ground Surface Elevation (m.a.s.l.)	Monitoring Well Installed	Borehole Depth (m)	Open Interval (m.b.g.s.)		Screen Interval (m.b.g.s.)		Stick-Up\Down*	Screen Length (m)	Well Dia. (m)
					Bottom	Top	Bottom	Top			
6-58A	05/07/00	83.648	Y	3.96	3.96	0.76	3.96	0.91	0.74	3.04	0.051
6-58B	05/07/00	83.664	Y	12.1	12.1	8.53	12.1	9.14	0.6	3.04	0.025
6-59	05/07/00	83.054	Y	4.42	4.42	0.45	4.42	0.76	- 0.17	3.65	0.051
6-60	04/07/00	84.066	Y	7.31	7.31	2.43	7.31	2.74	- 0.10	4.5	0.051
6-61	04/07/00	82.708	Y	6.09	6.09	0.61	6.09	0.91	- 0.14	5.18	0.051
6-62	04/07/00	83.186	N	3.66	-	-	-	-	-	-	-
6-63	11/07/00	83.28	Y	1.52	1.52	0.51	1.52	0.61	- 0.11	0.91	0.04
6-64	11/07/00	83.27	Y	1.52	1.52	0.51	1.52	0.61	- 0.10	0.91	0.04
6-65	11/07/00	83.874	Y	1.52	1.52	0.51	1.52	0.61	- 0.08	0.91	0.04
GW1	09/10/98	79.24	Y	2.4	2.4	0.6	2.4	0.9	0.74	1.5	0.051
GW2	09/10/98	78.94	Y	2.4	2.4	0.6	2.4	0.9	0.74	1.5	0.051
GW3	09/10/98	77.10	Y	2.7	2.7	0.8	2.7	1.2	-0.08	1.5	0.051
GW4	09/10/98	76.29	Y	2.7	2.7	0.8	2.7	1.2	-0.10	1.5	0.051
GW5	09/10/98	75.78	Y	2.7	2.7	0.8	2.7	1.2	0.76	1.5	0.051
GW6	09/10/98	76.58	Y	2.7	2.7	0.8	2.7	1.2	0.70	1.5	0.051
GW7	10/05/00	81.948	Y	4.27	3.96	0.305	3.96	0.91	0.34	3.05	0.04
PW6-1	14/10/99	84.7	Y	12.20	12.20	4.9	11.6	5.20	0.42	20	0.152

(m.b.g.s.): metres below ground surface; (m.a.s.l.): metres above sea level
*: - indicates stick down; + indicates stick up, measured relative to ground surface

LIST OF ABBREVIATIONS & TERMS USED IN BOREHOLE LOGS

DILLON CONSULTING

This form summarizes both field and selected lab test results on samples obtained from each borehole. An explanation of the various columns of the log follows.

DEPTH

All depths are given in metres (feet) measured from the ground surface unless otherwise noted.

ELEVATION/DEPTH

This column gives the elevation and depth of inferred geologic contacts. The elevation is referred to the datum shown in the general heading.

SYMBOLIC LOG

The symbolic log column displays standard hatching symbols used for description of soil and rock strata.

SOIL DESCRIPTION

A description of the soil strata using standard terminology is contained in this column. The terminology used for describing soil/strata is based on proportions of particle sizes present:

Term	Example	(%)
Trace	Trace sand	1 - 10
Some	Some sand	10 - 20
Adjective	Sandy	20 - 35
And	And sand	35 - 50
Noun	Sand	>50

Grain Size Classification*

* Based on Unified Soil Classification System ASTM D2487-85

Clay	<0.002 mm
Silt	0.002 - 0.075 mm
Sand	0.075 - 4.75 mm
Gravel	4.75 - 75 mm
Cobbles	75 - 200 mm
Boulder	>200 mm

Relative Density (Non-cohesive Soils)

	N (SPT)
Very Loose	0 - 4
Loose	4 - 10
Compact	10 - 30
Dense	30 - 50
Very dense	>50

Consistency (Cohesive Soils)

	N (SPT)	Undrained Shear Strength
Very soft	<2	0 to 12
Soft	2 - 4	12 to 25
Firm	4 - 8	25 to 50
Stiff	8 - 15	50 to 100
Very stiff	15 - 30	100 to 200
Hard	>30	Over 200

Dilatancy

None - No visible change in specimen.

Slow - Water appears slowly on surface of specimen during shaking and does not disappear or disappears slowly upon squeezing.

Rapid - Water appears quickly on the surface of specimen during shaking and disappears quickly upon squeezing.

Plasticity

	Liquid Limit (%)
Low Plasticity	<30
Medium Plasticity	30 - 50
High Plasticity	>50

LIST OF ABBREVIATIONS &
TERMS USED IN BOREHOLE LOGS
(continued)

DILLON CONSULTING

SAMPLE NO.

Samples are numbered numerically in the order which they were obtained in the borehole.

INTERVAL

The interval over which the sample was taken is indicated. The symbol represents the type of sampling method used. See form which follows for symbol descriptions.

SAMPLE TYPE

The first letter describes the sampling method and the second, the shipping container.

Sampling Method

A - Split Tube
B - Thin Wall Tube
C - Piston Sampler
D - Core Barrel
X - Denotes sample extracted from core, taken for laboratory analysis
E - Auger
F - Wash
G - Shovel

Shipping Container

N - Insert
O - Tube
P - Water Content Tin
Q - Plastic Jar
R - Glass Jar
S - Plastic Bag
T - Cloth Bag
U - Wooden Core Box
Y - Plastic Core box
Z - Discarded

'N' VALUE (BLOW COUNT)

The 'N' value obtained from the Standard Penetration Test (SPT). This test is carried out in accordance with ASTM D1586-84 and the 'N' value corresponds to the sum of the number of blows required by a 63.5 kg (140-lbs) hammer dropped 760 mm (30 in.) to drive a 50 mm (2-in.) split tube sampler the second and third 150 mm (6 in.) of penetration.

% RECOVERY

The percentage of the sample actually recovered based on field measurements is identified in this column. In case of rock, the length of rock core as a percentage of each core run is given.

LABORATORY ANALYSIS OF SOILS

Letter denotes analysis performed.

GEOTECHNICAL

a. Grain size
b. Moisture Content
c. Wet Density
d. Atterberg Limit(s)
e. Permeability
f. Cation Exchange Capacity
g. Mineralogical Identification
h. Other Geotechnical

CHEMICAL

i. Oils and Grease
j. TOC
k. Hydrocarbon(s)
l. Organic Compounds(s)
m. Major Ion(s)
n. Nutrient(s)
o. Metal(s)
p. Other Chemical

TEST DATA PLOTS

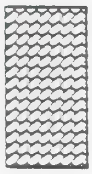
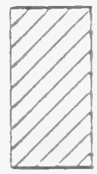
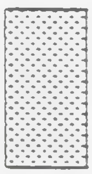
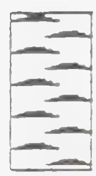
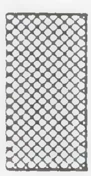
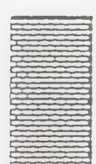
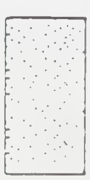
A column is reserved for plotting field and/or laboratory test data against depth, 'N' values, moisture contents and field vane shear strength are commonly plotted.

MONITOR INSTALLATION DETAILS

This column displays the details of groundwater monitor construction. See form which follows for description of symbols used to represent backfill materials.

LIST OF SYMBOLS USED IN BOREHOLE LOGS

SOIL UNITS

	Asphalt		Silt
	Concrete		Clay
	Topsoil		Peat
	Garbage		Till
	Fill		Shale
	Gravel		Limestone
	Sand		Igneous Rock

DILLON
CONSULTING

LIST OF SYMBOLS USED IN BOREHOLE LOGS

SAMPLING INTERVAL AND METHOD

- Splitspoon
- Thin Wall Tube
- Piston Sampler
- Core Barrel
- Auger
- Wash
- Shovel
- Sample Extracted for Laboratory Analysis

MONITOR INSTALLATION DETAILS

- Concrete
- Bentonite - pelletized
- Bentonite - powdered
- Bentonite Grout - Volclay, Gold
- Drill Cuttings
- Sand - No.1 grade
- Sand - No.3 grade
- Gravel
- Caved Materials
- Open Hole

DILLON	PROJECT No. 96-3564-17 DATUM: Geodetic	BOREHOLE No. MW6-11 Sheet 1 of 1
LOCATION: Rennie Street Landfill, Hamilton, Ontario		DATE: 22 September 1997 INSPECTOR: MRP

ELEV. DEPTH (m) 84.58	DESCRIPTION	SAMPLE NUMBER	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS
83.7 0.9	FILL Brown, sandy, street sweepings, no odours.					
	REFUSE Black, silty, odourous, moist.	1	AS	13	25	
	5.00m - Becoming saturated.	2	AS	22	50	
76.3 8.3	SILTY CLAY Reddish brown, trace odour, saturated.	3	AS	11	100	
		4	AS		100	
		5	AS		100	
71.6 13.0	SHALE Red, silty, weathered.					
71.5 13.1	13.11m - End of Borehole.					

N VALUE (□) (Blows/0.3m): 20 40 60 80

MONITOR INSTALLATION DETAILS: Stick Up 80cm

DEPTH (m): 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

NOTES:
(1) Monitoring well construction of 50mm diameter, SCH 40, flush-threaded, PVC riser pipe with a 1.52m long, No. 10 slot, screen.
(2) Water level taken Sept. 25, 1997 at 5.14m below ground surface.
(3) Water level taken Oct. 1, 1997 at 5.76m below ground surface.

DILLON

PROJECT No. 96-3564-17
DATUM: Geodetic

BOREHOLE No. MW6-12
Sheet 1 of 1

LOCATION: Rennie Street Landfill, Hamilton, Ontario

DATE: 23 September 1997
INSPECTOR: MRP

ELEV. DEPTH (m)	DESCRIPTION
84.38	
83.4 / 1.0	FILL Brown, sandy street sweepings, moist, no odours.
74.3 / 10.1	REFUSE Black, silty, odourous, moist. 5.10m - Becoming saturated.
71.6 / 12.8	SILT Reddish brown, trace clay, moist, trace odour.
71.3 / 13.1	SHALE Red, silty, weathered.

SAMPLE

NUMBER	TYPE	N VALUE	%RECOVERY
1	AS	17	25
2	AS	10	50
3	AS	9	100
4	AS	101	100
5	AS	17	100

N VALUE (□) (Blows/0.3m): 20 40 60 80

MONITOR INSTALLATION DETAILS: Stick Up 78cm

13.11m - End of Borehole.

NOTES:

(1) Monitoring well construction of 50mm diameter, SCH 40, flush-threaded, PVC riser pipe with a 1.52m long, No. 10 slot, screen.

(2) Water level taken Sept. 25, 1997 at 7.07m below ground surface.

(3) Water level taken Oct. 1, 1997 at 5.66m below ground surface.

DILLON

PROJECT No. 96-3564-17
DATUM: Geodetic

BOREHOLE No. MW6-13
Sheet 1 of 1

LOCATION: Rennie Street Landfill, Hamilton, Ontario

DATE: 23 September 1997
INSPECTOR: MRP

ELEV. DEPTH (m) 83.01	DESCRIPTION
	FILL Brown, sandy street sweepings, with concrete, trace odour.
81.8 1.3	REFUSE Black, silty, saturated, odourous.
74.6 8.4	SILTY CLAY Reddish brown, moist, some becoming trace odour.
70.1 13.0	SHALE Red, silty, weathered.
69.8 13.2	

SAMPLE NUMBER	TYPE	N VALUE	%RECOVERY
1	AS	3	25
2	AS	8	25
3	AS	20	0
4	AS	12	100
5	AS	11	75
6	AS		100

LABORATORY ANALYSIS

N VALUE (□) (Blows/0.3m) 20 40 60 80

MONITOR INSTALLATION DETAILS
Stick Up 82cm

12.18m - End of Borehole.

NOTES:

(1) Monitoring well construction of 50mm diameter, SCH 40, flush-threaded, PVC riser pipe with a 1.52m long, No. 10 slot, screen.
(2) Water level taken Sept. 25, 1997 at 5.83m below ground surface.
(3) Water level taken Oct. 1, 1997 at 4.44m below ground surface.

DILLON

PROJECT No. 96-3564-17
DATUM: Geodetic

BOREHOLE No. BH6-14
Sheet 1 of 1

DATE: 24 September 1997
INSPECTOR: MRP

LOCATION: Rennie Street Landfill, Hamilton, Ontario

ELEV. DEPTH (m)	DESCRIPTION
84.98	
83.5 / 1.5	FILL. Brown, sandy, street sweepings, with concrete, trace odour.
72.6 / 12.4	REFUSE. Black, silty, saturated, odourous.
71.3 / 13.7	SILTY CLAY. Red, saturated, some odour, becoming gravely at 13.40m.
71.1 / 13.9	SHALE. Red, silty, weathered.

13.87m - End of Borehole.

Notes:
(1) Monitoring well not installed. Borehole backfilled with drill cuttings, with bentonite seal at surface.

SAMPLE NUMBER	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS
1	AS	36	8	
2	AS	34	8	
3	AS	9	17	
4	AS	21	100	
5	AS	150	50	

N VALUE (□) (Blows/0.3m) 20 40 60 80

MONITOR INSTALLATION DETAILS

DILLON

PROJECT No. 96-3564-17
DATUM: Geodetic

BOREHOLE No. MW6-14A
Sheet 1 of 1

LOCATION: Rennie Street Landfill, Hamilton, Ontario

DATE: 20 October 1997
INSPECTOR: SLS

DEPTH (m)	ELEV. DEPTH (m)	SYMBOLIC LOG	DESCRIPTION	SAMPLE NUMBER	INTERVAL	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.3m) 20 40 60 80	MONITOR INSTALLATION DETAILS
	84.95										Stick Up 67cm
1	83.5 / 1.5		FILL Sand and Gravel Brown, coarse sand-medium gravel, poorly sorted, some debris (concrete). Dry-moist, no odour or visible staining.	1		ES					
2–12	72.8 / 12.2		REFUSE Black, clayey-silt, some sand, trace gravel. Debris present includes plastic, glass, paper, wire, organic material. Moderate to strong unidentified odour. 6.1m - Material becoming wet-saturated.	2		ES					
				3		ES					
				4		ES					
				5		ES					
				6		ES					
				7		ES					
				8		AS	28	50			
12–13	72.2 / 12.8		CLAYEY SILT Reddish-brown, trace fine gravel, moist to saturated, massive.	9		AS	10	50			

12.80m - End of Borehole.
Notes:
(1) Monitoring well constructed of 51mm diameter, Sch. 40, PVC, flush threaded riser pipe with a 1.52m long No. 10 slot screen.
(2) Water level measured at 6.08m below ground surface on October 21, 1997.

Depth scale (m): 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

DILLON

PROJECT No. 96-3564-17
DATUM: Geodetic

BOREHOLE No. MW6-15
Sheet 1 of 1

LOCATION: Rennie Street Landfill, Hamilton, Ontario

DATE: 20 October 1997
INSPECTOR: SLS

N VALUE (□) (Blows/0.3m): 20 40 60 80

MONITOR INSTALLATION DETAILS: Stick Up 83cm

ELEV. DEPTH (m)	DESCRIPTION	NUMBER	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS
84.94	FILL Sand and Gravel Brown, coarse sand-medium gravel, poorly sorted, some debris (concrete). Dry-moist, no odour or visible staining.	1	ES			
83.4 1.5	REFUSE Black, clayey-silt, some sand, trace gravel. Debris present includes plastic, glass, paper, wire, organic material. Moderate to strong unidentified odour.	2	ES			
		3	ES			
		4	ES			
	6.3m - Material becoming wet-saturated. Abundant fibrous (hair-like) material in refuse.	5	ES			
		6	ES			
		7	ES			
		8	AS	48	0	
72.8 12.2	CLAYEY SILT Reddish-brown, trace fine gravel, moist to saturated, massive.	9	AS	6	95	
72.1 12.8	12.80m - End of Borehole.					

Notes:
(1) Monitoring well constructed of 51mm diameter, Sch. 40, PVC, flush threaded riser pipe with a 1.52m long No. 10 slot screen.
(2) Water level measured at 6.29m below ground surface on October 21, 1997.

PROJECT No. 96-3564-17
DATUM: Geodetic

BOREHOLE No. BH6-16
Sheet 1 of 1

LOCATION: Rennie Street Landfill, Hamilton, Ontario

DATE: 20 October 1997
INSPECTOR: SLS

DEPTH (m)	ELEV. DEPTH (m) 84.92	DESCRIPTION	SAMPLE NUMBER	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS	N VALUE (Blows/0.3m) 20 40 60 80	MONITOR INSTALLATION DETAILS
0–1.4	83.5 1.4	FILL Sand and Gravel Brown, coarse sand-medium gravel, poorly sorted, some debris (concrete). Dry-moist, no odour or visible staining.	1	ES					
1.4–12.2	72.7 12.2	REFUSE Black, clayey-silt, some sand, trace gravel. Debris present includes plastic, glass, paper, wire, organic material. Moderate to strong unidentified odour. 6.1m - Material becoming wet-saturated.	2	ES					
			3	ES					
			4	ES					
			5	ES					
			6	ES					
			7	ES					
			8	AS	22	25			
12.2–12.8	72.1 12.8	CLAYEY SILT Reddish-brown, trace fine gravel, moist to saturated, massive.	9	AS	20	95			

12.80m - End of Borehole.
Notes:
(1) Monitoring well not installed. Hole backfilled with drill cuttings, with bentonite seal at surface.

DILLON

PROJECT No. 96-3564-17	BOREHOLE No. BH6-17	Sheet 1 of 1
DATUM: Geodetic		
LOCATION: Rennie Street Landfill, Hamilton, Ontario	DATE: 21 October 1997	INSPECTOR: SLS

DEPTH (m)	ELEV. DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.3m) 20 40 60 80	MONITOR INSTALLATION DETAILS
	84.75								
1		FILL Sand and Gravel Brown, coarse sand-medium gravel, poorly sorted, some debris (concrete). Dry-moist, no odour or visible staining.	1	ES					
2	83.0 1.8	REFUSE Black, clayey-silt, some sand, trace gravel. Debris present includes plastic, glass, paper, wire, organic material. Moderate to strong unidentified odour.	2	ES					
3									
4			3	ES					
5			4	ES					
6									
7			5	ES					
8		7.6m - Material becoming wet-saturated.	6	ES					
9									
10			7	ES					
11	74.1 10.7	CLAYEY SILT Reddish-brown, trace fine gravel, moist to saturated, massive.	8	AS	19	19		□	
	73.5 11.3	11.28m - End of Borehole. Notes: (1) Monitoring well not installed. Hole backfilled with drill cuttings, with bentonite seal at surface.							
12									
13									
14									
15									
16									
17									
18									
19									

DILLON

PROJECT No. 96-3564-17
DATUM: Geodetic

BOREHOLE No. BH6-18
Sheet 1 of 1

LOCATION: Rennie Street Landfill, Hamilton, Ontario

DATE: 21 October 1997
INSPECTOR: SLS

DEPTH (m)	ELEV. DEPTH (m) 84.86	DESCRIPTION	SAMPLE NUMBER	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS	N VALUE (Blows/0.3m) 20 40 60 80
0–1.6	83.3 / 1.6	FILL Sand and Gravel Brown, coarse sand-medium gravel, poorly sorted, some debris (concrete). Dry-moist, no odour or visible staining.	1	ES				
1.6–10.8	74.0 / 10.8	REFUSE Black, clayey-silt, some sand, trace gravel. Debris present includes plastic, glass, paper, wire, organic material. Moderate to strong unidentified odour.	2	ES				
			3	ES				
			4	ES				
		6.1m - Material becoming wet-saturated.	5	ES				
			6	ES				
			7	ES				
10.8–11.3	73.6 / 11.3	CLAYEY SILT Reddish-brown, trace fine gravel, moist to saturated, massive.	8	AS	13	19		

11.28m - End of Borehole.

Notes:
(1) Monitoring well not installed. Hole backfilled with drill cuttings, with bentonite seal at surface.

DILLON

PROJECT No. 96-3564-17
DATUM: Geodetic

BOREHOLE No. BH6-19
Sheet 1 of 1

LOCATION: Rennie Street Landfill, Hamilton, Ontario

DATE: 21 October 1997
INSPECTOR: SLS

DEPTH (m)	ELEV. DEPTH (m) 84.63	SYMBOLIC LOG	DESCRIPTION	SAMPLE NUMBER	INTERVAL	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.3m) 20 40 60 80	MONITOR INSTALLATION DETAILS
0–1.6	83.1 / 1.6		FILL Sand and Gravel Brown, coarse sand-medium gravel, poorly sorted, some debris (concrete). Dry-moist, no odour or visible staining.	1		ES					
1.6–10.7	74.0 / 10.7		REFUSE Black, clayey-silt, some sand, trace gravel. Debris present includes plastic, glass, paper, wire, organic material. Moderate to strong unidentified odour. 6.1m - Material becoming wet-saturated.	2		ES					
				3		ES					
				4		ES					
				5		ES					
				6		ES					
				7		ES					
10.7–11.1	73.5 / 11.1		CLAYEY SILT Reddish-brown, trace fine gravel, moist to saturated, massive.	8		AS	10	19		□	

11.13m - End of Borehole.
Notes:
(1) Monitoring well not installed. Hole backfilled with drill cuttings, with bentonite seal at surface.

DILLON

PROJECT No. 96-3564-17
DATUM: Geodetic

BOREHOLE No. BH6-20
Sheet 1 of 1

LOCATION: Rennie Street Landfill, Hamilton, Ontario

DATE: 21 October 1997
INSPECTOR: SLS

ELEV. DEPTH (m) 85.04	DESCRIPTION	SAMPLE NUMBER	TYPE
83.5 1.6	FILL Sand and Gravel Brown, coarse sand-medium gravel, poorly sorted, some debris (concrete). Dry-moist, no odour or visible staining.	1	ES
74.4	REFUSE Black, clayey-silt, some sand, trace gravel. Debris present includes plastic, glass, paper, wire, organic material. Moderate to strong unidentified odour.	2	ES
		3	ES
		4	ES
	6.1m - Material becoming wet-saturated.	5	ES
		6	ES
		7	ES
10.7	10.66m - End of Borehole. Notes: (1) Monitoring well not installed. Hole backfilled with drill cuttings, with bentonite seal at surface.		

Columns not filled: INTERVAL, N VALUE, %RECOVERY, LABORATORY ANALYSIS, N VALUE (□) (Blows/0.3m) 20 40 60 80, MONITOR INSTALLATION DETAILS. Depth scale (m): 1–19.

DILLON

PROJECT No. 96-3564-17
DATUM: Geodetic

BOREHOLE No. MW6-21
Sheet 1 of 1

LOCATION: Rennie Street Landfill, Hamilton, Ontario

DATE: 28 April 1998
INSPECTOR: SLS

DEPTH (m)	ELEV. DEPTH (m) 85.04	DESCRIPTION	SAMPLE NUMBER	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.3m) 20 40 60 80	MONITOR INSTALLATION DETAILS Stick Up 73 cm
		FILL Sand and Gravel Brown, dry, loose to compact.	1	AS					
1			2	AS			p		
2			3	AS					
	82.3		4	AS					
3	2.8	REFUSE Black, paper, plastic, wood, moist, strong odour.	5	AS			p		
4			6	AS					
5			7	AS			p		
6			8	AS					
			9	AS					
7			10	AS					
8			11	AS			p		
9			12	AS					
	75.3		13	AS					
10	9.8	CLAYEY SILT Reddish-brown, trace fine gravel, moist to saturated, massive.	14	AS					
11	73.9		15	AS			p		
	11.1	SHALE Red, fractured, dry to moist.							
12									
13				DU					
14	70.9								
	14.2	14.17m - End of Borehole Notes: (1) Monitoring well constructed of 50mm diameter, Sch. 40, PVC riser pipe with a 3.05m long, No. 10 slot, PVC well screen. (2) Water level measured on May 5, 1998 at 6.55 metres below ground surface. (3) This borehole was drilled in association with Peto MacCallum.							
15									
16									
17									
18									
19									

DILLON

PROJECT No. 96-3564-17
DATUM: Geodetic

BOREHOLE No. MW6-22
Sheet 1 of 1

LOCATION: Rennie Street Landfill, Hamilton, Ontario

DATE: 27 April 1998
INSPECTOR: SLS

ELEV. DEPTH (m) 84.76	DESCRIPTION	SAMPLE NUMBER	TYPE	LABORATORY ANALYSIS
	FILL Sand and Gravel Brown, dry, loose to compact.	1	AS	
		2	AS	p
82.9 1.8	REFUSE Paper, plastic, wood, debris.	3	AS	
		4	AS	p
		5	AS	
		6	AS	
		7	AS	
		8	AS	
		9	AS	p
		10	AS	
		11	AS	p
		12	AS	
		13	AS	
		14	AS	
		15	AS	
73.4 11.3	CLAYEY SILT Reddish-brown, trace fine gravel, moist to saturated, massive.	16	AS	p
		17	AS	
71.5 13.3	SHALE Red, fractured, dry to moist.	18	AS	
70.7 14.0		19	AS	

Column headings also printed: DEPTH (m); SYMBOLIC LOG; SAMPLE: INTERVAL, N VALUE, %RECOVERY; N VALUE (□) (Blows/0.3m) 20 40 60 80; MONITOR INSTALLATION DETAILS — Stick Up 73 cm.

14.02m - End of borehole
Notes:
(1) Monitoring well constructed of 50mm diameter, Sch. 40, flush threaded, PVC riser pipe with a 3.05m long, No. 10 slot PVC well screen.
(2) Water level measured on May 5, 1998 at 5.15 metres below ground surface.
(3) This borehole was drilled in assocaiation with Peto MacCallum.

DILLON

PROJECT No. 96-3564-17
DATUM: Geodetic

BOREHOLE No. MW6-23
Sheet 1 of 1

DATE: 23 April 1998
INSPECTOR: SLS

LOCATION: Rennie Street Landfill, Hamilton, Ontario

DEPTH (m)	ELEV. DEPTH (m) 84.83	SYMBOLIC LOG	DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE N VALUE	SAMPLE %RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.3m) 20 40 60 80	MONITOR INSTALLATION DETAILS Stick Up 82 cm
			FILL Sand and Gravel Brown, dry, loose to compact.	1		AS					
1				2		AS			p		
2				3		AS					
				4		AS					
3				5		AS					
4	80.6 4.3			6		AS					
5			REFUSE Black, paper, plastic, wood, debris.	7		AS			p		
				8		AS					
6				9		AS			p		
7				10		AS					
8				11		AS					
				12		AS					
9				13		AS					
10				14		AS					
11	73.6 11.3			15		AS			p		
			CLAYEY SILT Reddish-brown, trace fine gravel, moist to saturated, massive.	16		AS			p		
12	72.0 12.8			17		AS					
13	71.4 13.4		GRAVEL	18		AS					
	70.8 14.0		SHALE Red, fractured, dry to moist.	19		AS					
14			14.02m - End of Borehole								
15											
16											
17											
18											
19											

Notes:
(1) Monitoring well constructed of 50mm diameter, Sch. 40, flush threaded, PVC riser pipe with a 3.05m long, No. 10 slot PVC well screen.
(2) Water level measured on May 5, 1998 at 6.43 metres below the top of the pipe.
(3) This borehole was drilled in association with Peto MacCallum.

DILLON

PROJECT No. 96-3564-17
DATUM: Geodetic

BOREHOLE No. MW6-24
Sheet 1 of 1

LOCATION: Rennie Street Landfill, Hamilton, Ontario

DATE: 23 April 1998
INSPECTOR: SLS

SAMPLE NUMBER	INTERVAL	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS
1		AS	13	83	
2		AS		100	
3		AS	7	100	p
4		AS	11	100	
5		AS	10	100	
6		AS	4	12	
7		AS	7	8	
8		AS	3	12	p
9		AS	4	25	
10		AS	5	0	p
11		AS	12	0	
12		AS	9	8	
13		AS	8	0	p
14		AS	5	83	p

ELEV. / DEPTH (m)	DESCRIPTION
84.90	FILL Sand and Gravel Dark brown, some silt, very poorly sorted, dry, loose. 1.3m - Spoon refusal on concrete.
83.5 / 1.4	FILL Clayey Silt Dark brown-red-black, some sand and gravel, poorly sorted, dry.
82.7 / 2.2	FILL Clayey Silt Grey-dark grey, some stones 1 to 30mm long present, moist, blocky. Organic material present.
81.3 / 3.6	REFUSE Black, paper, plastic, wood, debris. Odour present. Becoming saturated.
74.9 / 10.0	CLAYEY SILT Red, moist, massive, no stones, native.
74.4 / 10.5	10.52m - End of Borehole

N VALUE (□) (Blows/0.3m): 20 40 60 80

MONITOR INSTALLATION DETAILS: Stick Up 74 cm

Notes:
(1) Monitoring well constructed of 50mm diameter, Sch. 40, flush threaded, PVC riser pipe with a 3.05m long, No. 10 slot PVC well screen.
(2) Water level measured on May 5, 1998 at 5.91 metres below ground surface.

DILLON

PROJECT No. 96-3564-17
DATUM: Geodetic

BOREHOLE No. BH6-27
Sheet 1 of 1

LOCATION: Rennie Street Landfill, Hamilton, Ontario

DATE: 27 April 1998
INSPECTOR: SLS

ELEV. DEPTH (m) 84.83	DESCRIPTION	SAMPLE NUMBER	INTERVAL	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/0.3m) 20 40 60 80	MONITOR INSTALLATION DETAILS
	FILL Sand and Gravel Brown, some silt, very poorly sorted, dry, compact.	1		AS	22	83			
	Becoming wet.	2		AS	28	83	p		
	Brick red, increasing clay and silt components, trace of debris, wet, compact.	3		AS	11	83			
82.6 2.3	REFUSE Wood, paper.	4		AS	6	12			
		5		AS	20	8	p		
		6		AS	7				
		7		AS	8				
		8		AS	6				
		9		AS	7				
		10		AS	5	8	p		
		11		AS	26	50			
		12		AS	20	8			
		13		AS	9	12			
		14		AS	16	25	p		
73.9 10.9	CLAYEY SILT Red, stiff, some stones.	15		AS	6	8	p		
73.6 11.3	11.28m - End of Borehole Notes: (1) No monitoring well installed. Backfilled with drill cuttings.								

DEPTH (m): 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

DILLON

PROJECT No. 96-3564-17
DATUM: Geodetic

BOREHOLE No. MW6-28
Sheet 1 of 1

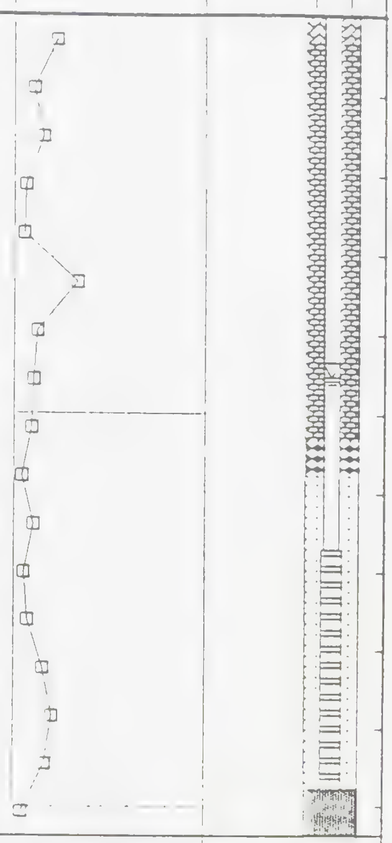
LOCATION: Rennie Street Landfill, Hamilton, Ontario

DATE: 23 April 1998
INSPECTOR: SLS

ELEV. DEPTH (m) 84.86	DESCRIPTION	NUMBER	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS
	FILL Sand and Gravel Brown-black, some silt and stones, poorly sorted, dry to moist, dense.	1	AS	22	100	
		2	AS	10	100	p
	Becoming moist and some red colouration present.	3	AS	15	100	
	Some refuse is present.	4	AS	6	12	p
81.8	Becoming wet.	5	AS	5	50	
3.1	REFUSE Paper, plastic, debris, wood.	6	AS	33	12	
		7	AS	12	8	
		8	AS	10	42	
		9	AS	9	50	
		10	AS	4	83	
		11	AS	10	83	p
		12	AS	5	83	
		13	AS	7	12	
		14	AS	15	17	p
		15	AS	20	17	
75.0		16	AS	16	8	p
9.8	CLAYEY SILT Red, moist, dense, massive, some stones.	17	AS	4	75	
74.5 10.4	10.37m - End of Borehole					

N VALUE (□) (Blows/0.3m) 20 40 60 80

MONITOR INSTALLATION DETAILS
Stick up 68 cm



Notes:
(1) Monitoring well constructed of 50mm diameter Sch. 40, flush threaded PVC riser pipe with a 3.05m long, No. 10 slot well screen.

DEPTH (m): 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

DILLON

PROJECT No. 96-3564-17
DATUM: Geodetic

BOREHOLE No. BH6-29
Sheet 1 of 1

LOCATION: Rennie Street Landfill, Hamilton, Ontario

DATE: 24 April 1998
INSPECTOR: SLS

ELEV. DEPTH (m)	DESCRIPTION	NUMBER	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS
84.78						
84.5 / 0.3	FILL Sand and gravel	1	ES			
83.6 / 1.2	CONCRETE Rebar and rubble present	2	AS			
	FILL Clayey Silt Red, firm, massive, some stones.	3	AS	24	83	p
		4	AS	5	75	
	3.1m - Becoming grey, with increasing moisture content.	5	AS	7	83	p
80.7 / 4.1		6	AS	10	25	
	WASTE Paper, wood, plastic and debris.	7	AS	7	4	
		8	AS	7	21	
		9	AS	7	29	p
		10	AS	3	12	p
		11	AS	8	50	
		12	AS	30	50	
		13	AS	33	33	
		14	AS	20	58	
		15	AS	17	25	
72.9 / 11.9		16	AS	5		
72.7 / 12.0	CLAYEY SILT Red, some fine gravel.					

12.04m - End of Borehole

Notes:
(1) No monitoring well installed. Back filled with drill cuttings.

DILLON

PROJECT No. 96-3564-26
DATUM: Geodetic

BOREHOLE No. MW6-36
Sheet 1 of 1

PROJECT: Red Hill Creek Expressway Site Contamination Investigations
LOCATION: Nash Road and Brampton Street, Hamilton, Ontario

DATE: 18 September 1998
INSPECTOR: ADD

ELEV. DEPTH (m)	DESCRIPTION	NUMBER	TYPE	N VALUE	%RECOVERY
	FILL - Sand and Gravel				
0.4	Reddish brown, moist, loose, some clay, cement fragments. Mild hydrocarbon odour detected.	1	ES		
	CLAY AND SAND	2	AS	14	75
1.8	Brown, wet, stiff, iron oxidation, grey mottling. Moderate hydrocarbon odour detected.	3	AS	29	79
	CLAY Greyish brown, dry, stiff, red streaks. Slight hydrocarbon odour detected. 2.15m - No hydrocarbon odour detected. 3.05m - Becoming moist.	4	AS	19	100
		5	AS	19	67
		6	AS	100	
4.3	CLAY Red, moist, stiff, trace gravel.	7	AS	100	
4.9	LIMESTONE SHALE Grey, green streaks, highly weathered.				
5.0 / 5.3	SHALE Red, moist, stiff, trace gravel, very weathered.				

5.34m - End of borehole

Notes:
(1) Monitoring well constructed of 50mm diameter, Sch. 40, flush-threaded, PVC riser with a 3.05m long, No. 10 slot screen.
(2) Water level taken on October 1, 1998 at 3.85 metres below ground surface.

MONITOR INSTALLATION DETAILS: STICKUP 0.83

N VALUE (Blows/): 20 40 60 80

DEPTH (m): 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

DILLON

PROJECT No. 96-3564-27

DATUM: Geodetic

BOREHOLE No. MW6-42

Sheet 1 of 1

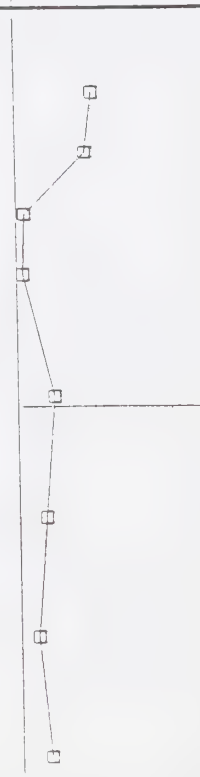
LOCATION: Rennie Street Landfill

DATE: 10 October 1998

INSPECTOR: SLS

ELEV. / DEPTH (m)	DESCRIPTION	NUMBER	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS
84.09						
83.6 / 0.5	FILL - Sand and gravel Light brown, dry, loose, fine to medium grained sand, medium grained gravel.	1	ES			
		2	AS	40	67	
82.6 / 1.5	FILL Silty clay Light brown, dry, dense, minor gravel. Rubble, concrete, and asphalt present.	3	AS	36	67	
81.7 / 2.4	FILL - Silty clay Reddish brown, dry, dense. Rubble and concrete present.	4	AS	4	42	
	REFUSE Black, moist. Slight odour present. Papers, metal, glass present.	5	AS	3	33	
	Waxed paper present.	6	AS	19	75	
	Shingles and roofing material present.	7	AS	14	75	p
		8	AS	9	12	p
74.8 / 9.3	SILTY CLAY Red, moist, soft.	9	AS	15	83	
74.3 / 9.8	9.75m - End of Borehole					

N VALUE (□) (Blows/) 20 40 60 80



MONITOR INSTALLATION DETAILS

Stickup 0.93m

Notes:

(1) Monitoring well constructed of 50mm diameter, Sch. 40, flush-threaded, PVC riser pipe with a 1.52m long, No. 10 slot, screen.

(2) Water level was taken on October 13, 1998 at 5.49 metres below ground surface.

DILLON	PROJECT No. 96-3564-27	BOREHOLE No. MW6-43
	DATUM: Geodetic	Sheet 1 of 1
LOCATION:	Rennie Street Landfill	DATE: 10 October 1998 INSPECTOR: SLS

Ground elevation: 83.92 m. Monitor installation details: StickUp 0.80m.

ELEV. / DEPTH (m)	DESCRIPTION
83.92 / 0.0	FILL - Silty clay Dark brown to red, dry, loose, some sand, some pit run gravel, poorly sorted. Concrete rubble, bricks present.
82.4 / 1.5	REFUSE Silty clay, moist, with refuse present.
81.6 / 2.3	REFUSE Black, wet, loose, strong odour detected. Wood fragments, shingle fragments present. Newspapers present. Waxed paper present.
77.5 / 6.4	Silty clay Grey, moist, soft, some gravel, some red clay.
77.2 / 6.7	REFUSE Black, wet, loose, strong odour detected. Wood fragments, shingles, newspapers.
71.6 / 12.4	SILTY CLAY Red moist, soft.
71.1 / 12.8	12.80m - End of Borehole

SAMPLE NUMBER	TYPE	N VALUE	%RECOVERY
1	ES	28	
2	AS	6	50
3	AS	6	83
4	AS	10	83
5	AS	17	83
6	AS	8	83
7	AS	14	83
8	AS	14	83
9		15	0
10	AS	4	0
11	AS	12	83

Notes:
(1) Monitoring well constructed of 50mm diameter, Sch. 40, flush-threaded, PVC riser pipe with a 3.05m long, No. 10 slot, screen.
(2) Water level was measured on October 13, 1998 at 5.49 metres below ground surface.

DILLON

PROJECT No. 96-3564-27
DATUM: Geodetic

BOREHOLE No. MW6-44
Sheet 1 of 1

DATE: 10 October 1998
INSPECTOR: SLS

LOCATION: Rennie Street Landfill

ELEV. DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS
87.16						
	FILL - Sandy silt Light brown, dry, loose, minor gravel, wood present, poorly sorted.	1	ES			
86.4 0.8	FILL - Sand and gravel Reddish brown, dry, loose, some silt/clay, glass and bricks present.	2	AS	15	50	
	Becoming moist.	3	AS	10	67	
	Ash, debris, road sweepings present.	4	AS	26	67	p
	Concrete rubble, stones present. Becoming wet.	5	AS	41	58	
82.6 4.6	REFUSE Black, moist. Glass, wood, concrete rubble present.	6	AS	4	33	
	Wood, paper, glass, plastic present.	7	AS	4	25	p
		8	AS	8	33	
		9	AS	9	33	
		10	AS	13	50	
		11	AS	20	33	
		12	AS	7	0	
		13	AS	7	0	
71.3 15.9	SILTY CLAY Grey, moist, soft.					
70.4 16.8	16.77m - End of Borehole - Spoon Refusal.					

N VALUE (Blows/) 20 40 60 80

MONITOR INSTALLATION DETAILS: stickdwn 0.08m

Notes:
(1) Monitoring well constructed of 50mm diameter, Sch. 40, flush-threaded, PVC riser pipe, with a 3.05m long, No. 10 slot, screen.
(2) Water level measured on October 13, 1998 at 11.68 metres below ground surface.

DILLON

PROJECT No. 96-3564-27 | BOREHOLE No. BH6-45
DATUM: Geodetic | Sheet 1 of 1

LOCATION: Rennie Street Landfill | DATE: 10 October 1998
INSPECTOR: SLS

DEPTH (m)	ELEV. DEPTH (m) 84.12	DESCRIPTION	SAMPLE NUMBER	INTERVAL	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/) 20 40 60 80	MONITOR INSTALLATION DETAILS
		FILL Gravel Reddish brown, dry, loose, pea gravel.	1		ES					
1	82.6 1.5	FILL Silty clay Reddish grey, wet, soft, some sand, some gravel.	2		AS	10	67			
2	82.1 2.0	REFUSE Black, wet, loose. Papers, cloth, plastic present.	3		AS	6	42			
3–4		Increase in clay and silt content.	4		AS	4	33	p		
5–6			5		AS	8	0			
7–8			6		AS	5	8	p		
9	74.7 9.5	SILTY CLAY Red, moist, soft.	7		AS	6	50			
10	74.4 9.8	9.75m - End of Borehole Notes: (1) No monitoring well installed. Backfilled with drill cuttings.								
11–19										

DILLON

PROJECT No. 96-3564-27
DATUM: Geodetic

BOREHOLE No. BH6-46
Sheet 1 of 1

LOCATION: Rennie Street Landfill

DATE: 10 October 1998
INSPECTOR: SLS

ELEV. DEPTH (m)	DESCRIPTION	NUMBER	TYPE	N VALUE	%RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/) 20 40 60 80	MONITOR INSTALLATION DETAILS
85.50								
	FILL Asphalt and gravel	1	ES					
84.7 0.8	Grey, dry, loose, some brown sand, some medium gravel, poorly sorted.	2	AS		50			
84.5 1.1	FILL Gravel Brown to red, wet, loose, fine grained.	3	AS		58			
	REFUSE Silty clay, black, wet. Glass present. Wood, papers, glass present.	4	AS		58			
		5	AS		33			
		6	AS		25	p		
		7	AS		25			
		8	AS		25			
		9	AS		25	p		
74.5		10	AS	6	25		□	
11.0 74.2 11.3	SILTY CLAY Red, moist, soft.							

11.28m - End of Borehole

Notes:

(1) No monitoring well installed. Backfilled with drill cuttings to grade.

Project No: 00-7447

Project: Rennie Street Landfill Investigation

Client: Region of Hamilton Wentworth

Location: Rennie Street Landfill

Borehole ID: MW6-47

Enclosure: 1

Supervised By: MLG

DILLON CONSULTING

Depth (ft)	Depth (m)	Symbol	Description	Elevation	Number	Type	Sample	Recovery %	Blow Count	Organic Vapour (ppm)	Well Data	Remarks
0	0		Ground Surface	84.83								
0–6	0–2		*FILL* Sand and Gravel to silt, brown, dry, contains asphalt debris, damp	82.91	1	SS		63	66			Stickup 0.8 m; bentonite seal
					2	SS		63	31			
7–27	2–8		*WASTE* Black sandy silty, damp to wet, contains paper and plastic debris		3	SS		17	12			
			becoming wet		4	SS		16	71			
					5	SS		33	20			Water level on 05/15/00
			oily sheen on waste	76.6	6	SS		17	23			
			End of Borehole									

ORGANIC VAPOUR: %LEL 25, 50, 75; ppm 100, 200, 300

Drilled By: Atcost Soil Drilling Inc.

Drill Method: Hollow Stem Augers

Drill Date: May 1, 2000

Vapour Unit: eppm

Dillon Consulting Limited
1425 Bishop Street
Cambridge, Ontario, N1R 6J9
(519) 623-6761

Hole Size: 21.6 cm (8.5 inch)

Datum: metres above sea level

Sheet: 1 of 1

Top of Pipe: 85.63

Project No: 00-7447

Project: Rennie Street Landfill Investigation

Client: Region of Hamilton Wentworth

Location: Rennie Street Landfill

Borehole ID: MW6-48

Enclosure: 1

Supervised By: MLG

DILLON CONSULTING

Depth (ft)	Depth (m)	Description	Elevation	Number	Type	Recovery %	Blow Count	Remarks
		Ground Surface	87.091					
0	0	*TOP SOIL*		1	SS	50	15	Stickup 0.75 m
5	1.5	*FILL* Silty sand and gravel to clayey silt, dry to damp, with some asphalt and brick debris.		2	SS	38	16	
10	3			3	SS	80	24	
15	4.6			4	SS	80	10	
20	6	*WASTE* Black, damp to wet, contains paper plastic, wood, and rubber debris	80.995	5	SS	21	6	
25	7.6			6	SS	8	50	
30	9			7	SS	33	95	Water level on 05/15/00
35	10.7			8	SS	50	33	
40	12	End of Borehole	74.899					

ORGANIC VAPOUR: %LEL 25 50 75; ppm 100 200 300

Drilled By: Atcost Soil Drilling Inc.

Drill Method: Hollow Stem Augers

Drill Date: May 1, 2000

Vapour Unit: eppm

Dillon Consulting Limited
1425 Bishop Street
Cambridge, Ontario, N1R 6J9
(519) 623-6761

Hole Size: 21.6 cm (8.5 inch)

Datum: metres above sea level

Sheet: 1 of 1

Top of Pipe: 87.84

Project No: 00-7447

Project: Rennie Street Landfill Investigation

Client: Region of Hamilton Wentworth

Location: Rennie Street Landfill

Borehole ID: MW6-49A

Enclosure: 1

Supervised By: MLG

DILLON CONSULTING

Depth (m)	Description	Elevation	Well Data	Remarks
	Ground Surface	84.335		
0	***FILL (inferred from MW6-49B)*** Sand and gravel to silty sand, brown, dry to moist, some clay.	82.607		Stickup 0.82m
	CLAYEY SILT Red-brown to grey, trace small gravel, damp	81.104		Water level on 05/15/00
	SHALE(WEATHERED) weathered, damp, reddish brown, generally weathered to silty sand with some portions being clayey silt	78.3		
	SHALE Red/grey, mottled, some voids, fractured sections	76.715		
	End of Borehole			

SUBSURFACE PROFILE: Depth (ft / m), Symbol, Description, Elevation

SAMPLE DATA: Number, Type, Sample, Recovery %, Blow Count

ORGANIC VAPOUR: %LEL 25 50 75; ppm 100 200 300

Drilled By: Atcost Soil Drilling Inc.

Drill Method: Hollow Stem Augers

Drill Date: May 2, 2000

Vapour Unit: eppm

Dillon Consulting Limited
1425 Bishop Street
Cambridge, Ontario, N1R 6J9
(519) 623-6761

Hole Size: 21.6 cm (8.5 inch)

Datum: metres above sea level

Sheet: 1 of 1

Top of Pipe: 85.16

Project No: 00-7447

Project: Rennie Street Landfill Investigation

Client: Region of Hamilton Wentworth

Location: Rennie Street Landfill

Borehole ID: MW6-49B

Enclosure: 1

Supervised By: MLG

DILLON CONSULTING

SUBSURFACE PROFILE / SAMPLE DATA

Depth (m)	Description	Elevation	Number	Type	Recovery %	Blow Count
0	Ground Surface	84.335				
0–1.73	*FILL* Sand and gravel to silty sand, brown, dry to moist, some clay.	82.607	1	GS	-	-
			2	SS	38	18
1.73–3.23	*CLAYEY SILT* native, brown to red-brown, damp	81.104				
3.23–6.16	*SHALE (WEATHERED)* weathered, damp, reddish brown, generally weathered to silty sand with some portions being clayey silt	78.172	3	SS	80	79
			4	SS	80	98 10"
			5	SS	67	50 4"
6.16–10.82	*SHALE* Red/grey mottled, some voids, fractured sections	73.515	6	CS	100	-
			7	CS	100	-
			8	CS	100	-
	End of Borehole					

ORGANIC VAPOUR: %LEL 25 50 75; ppm 100 200 300

Well Data

Remarks

Stickup 0.77 m

Augered to 6.24 m, cored below that depth

Water level on 05/15/00

Drilled By: Atcost Soil Drilling Inc.

Drill Method: Hollow Stem Augers

Drill Date: May 2, 2000

Vapour Unit: eppm

Dillon Consulting Limited
1425 Bishop Street
Cambridge, Ontario, N1R 6J9
(519) 623-6761

Hole Size: Cored Hole 7.62 cm

Datum: metres above sea level

Sheet: 1 of 1

Top of Pipe: 85.102

Project No: 00-7447

Project: Rennie Street Landfill Investigation

Client: Region of Hamilton Wentworth

Location: Rennie Street Landfill

Borehole ID: MW6-50

Enclosure: 1

Supervised By: MLG

DILLON CONSULTING

Depth (m)	Symbol	Description	Elevation	Number	Type	Sample	Recovery %	Blow Count	Organic Vapour (%LEL 25 50 75 / ppm 100 200 300)	Well Data	Remarks
0		Ground Surface	83.207								
0–1		**TOP SOIL** brown, sandy silt to gravel, moist	81.912	1	SS		42	27			Stickup 0.51m
				2	SS		42	9			
		WASTE black stained, silty gravel, moist, contains glass		3	SS		100	18			
				4	SS		42	59			Water level on 05/15/00
		SILT Brown, some sand, trace gravel, damp becoming moist at depth		5	SS		80	50 5"			
				6	SS		100	50 4"			
6		End of Borehole	77.111								

Drilled By: Atcost Soil Drilling Inc.

Drill Method: Hollow Stem Augers

Drill Date: May 3, 2000

Vapour Unit: eppm

Dillon Consulting Limited
1425 Bishop Street
Cambridge, Ontario, N1R 6J9
(519) 623-6761

Hole Size: 21.6 cm (8.5 inch)

Datum: metres above sea level

Sheet: 1 of 1

Top of Pipe: 83.715

Project No: 00-7447	**Borehole ID: MW6-51A**
Project: Rennie Street Landfill	
Client: Region of Hamilton Wentworth	**Enclosure:** 1
Location: Rennie Street	**Supervised By:** MLG

DILLON CONSULTING

SUBSURFACE PROFILE				SAMPLE DATA					ORGANIC VAPOUR	Well Data	Remarks
Depth (ft / m)	Symbol	Description	Elevation	Number	Type	Sample	Recovery %	Blow Count	%LEL 25 50 75 / ppm 100 200 300		
0 ft / 0 m		Ground Surface	76.217								
0–5 ft / 0–1.5 m		***SANDY SILT*** Sandy silt with some gravel, brown, dry to moist.	74 693								Stickup 0.75m concrete seal Water level 15/05/00
5–10 ft / 1.5–3 m		***CLAY*** brown, damp, trace silt, some grey/black staining	73.169								
			73.017								
10–15 ft / 3–4.6 m		***SHALE*** weathered, damp, reddish brown, generally weathered to silty sand with some portions being clayey silt									Pipe 3.2 cm. dia. Pipe pushed into place. No sand pack possible.
		End of Borehole									

Drilled By: Sonic Soil Sampling Inc.
Drill Method: Pionjar 120
Drill Date: May__, 2000
Vapour Unit: eppm

Dillon Consulting Limited
1425 Bishop Street
Cambridge, Ontario, N1R 6J9
(519) 623-6761

Hole Size: 5.0 cm (2 inches)
Datum: metres above sea level
Sheet: 1 of 1
Top of Pipe:

Project No: 00-7447	**Borehole ID: MW6-51B**
Project: Rennie Street Landfill Investigation	
Client: Region of Hamilton Wentworth	**Enclosure:** 1
Location: Rennie Street Landfill	**Supervised By:** MLG

DILLON CONSULTING

Depth (m)	Description	Elevation	Number	Type	Recovery %	Blow Count	Well Data / Remarks
0	Ground Surface	76.028					Stickup 1.05 m Water level 15/05/00
	SANDY SILT Sandy silt with some gravel, brown, dry to moist.	74.504	1	SS	40	-	
			2	SS	83	-	
	CLAY brown, damp, trace silt, some grey/black staining, moist.	72.98	3	SS	87	-	
			4	SS	100	-	Pipe 3.2 cm. dia. Pipe pushed into place. No sand pack possible. Concrete seal at surface
	SHALE (WEATHERED) weathered, damp, reddish brown, generally weathered to silty sand with some portions being clayey silt. Bedrock becoming more competant at bottom.	70.846	5	SS	100	-	
			6	SS	100	-	
			7	SS	100	-	
	End of Borehole						

ORGANIC VAPOUR: %LEL 25 50 75; ppm 100 200 300

Drilled By: Sonic Soil Sampling Inc.	**Dillon Consulting Limited**	Hole Size: 5.0 cm (2 inches)
Drill Method: Pionjar 120	**1425 Bishop Street**	Datum: metres above sea level
Drill Date: May 10, 2000	**Cambridge, Ontario, N1R 6J9**	Sheet: 1 of 1
Vapour Unit: eppm	**(519) 623-6761**	Top of Pipe: 77.084

Project No: 00-7447

Project: Rennie Street Landfill Investigation

Client: Region of Hamilton Wentworth

Location: Rennie Street Landfill

Borehole ID: MW6-52A

Enclosure: 1

Supervised By: MLG

DILLON CONSULTING

Depth (ft / m)	Symbol	Description	Elevation	Number	Type	Sample	Recovery %	Blow Count	Organic Vapour (%LEL 25 50 75; ppm 100 200 300)	Well Data	Remarks
0		Ground Surface	75.333								Stickup 0.96m Water level = 75.94 15/05/00 Pipe 3.2 cm. dia. Pipe pushed into place. No sand pack Concrete seal at surface
0–1.2 m		**SANDY SILT** Sandy silt trace gravel, moist.									
1.2–2.3 m		**CLAY** reddish brown, trace silt, some grey/black staining, moist	73.047								
		End of Borehole									

Drilled By: Sonic Soil Sampling Inc.

Drill Method: Pionjar 120

Drill Date: May 9, 2000

Vapour Unit: eppm

Dillon Consulting Limited
1425 Bishop Street
Cambridge, Ontario, N1R 6J9
(519) 623-6761

Hole Size: 5.0 cm (2 inches)

Datum: metres above sea level

Sheet: 1 of 1

Top of Pipe: 76.288

Project No: 00-7447

Project: Rennie Street Landfill Investigation

Client: Region of Hamilton Wentworth

Location: Rennie Street Landfill

Borehole ID: MW6-52B

Enclosure: 1

Supervised By: MLG

DILLON CONSULTING

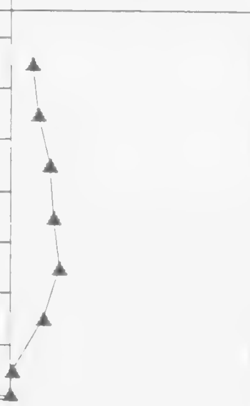
SUBSURFACE PROFILE

Depth (m)	Description	Elevation
0	Ground Surface	75.333
0	***SANDY SILT*** Sandy silt trace gravel, moist.	
	CLAY reddish brown, trace silt, some grey/black staining, moist	
	SHALE (WEATHERED) weathered, damp, reddish brown, generally weathered to silty sand with some portions being clay to clayey silt.	71.066
	End of Borehole	69.947

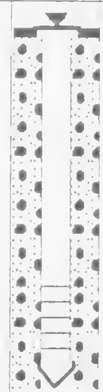
SAMPLE DATA

Number	Type	Recovery %	Blow Count
1	SS	33	-
2	SS	93	-
3	SS	100	-
4	SS	100	-
5	SS	100	-
6	SS	100	-
7	SS	100	-
8	SS	36	

ORGANIC VAPOUR



Well Data



Remarks

Stickup 0.91m
Concrete Seal at surface
Water level 15/05/00 = 75.49

Pipe 3.2 cm. dia. Pipe pushed into place. No sand pack

Drilled By: Sonic Soil Sampling Inc.
Drill Method: Pionjar 120
Drill Date: May 9, 2000
Vapour Unit: eppm

Dillon Consulting Limited
1425 Bishop Street
Cambridge, Ontario, N1R 6J9
(519) 623-6761

Hole Size: 5.0 cm (2 inches)
Datum: metres above sea level
Sheet: 1 of 1
Top of Pipe: 76.246

Project No: 00-7447

Project: Rennie Street Landfill Investigation

Client: Region of Hamilton Wentworth

Location: Rennie Street Landfill

Borehole ID: MW6-53A

Enclosure: 1

Supervised By: MLG

DILLON CONSULTING

Depth (ft / m)	Symbol	Description	Elevation	Number	Type	Sample	Recovery %	Blow Count	Organic Vapour (%LEL 25 50 75 / ppm 100 200 300)	Well Data	Remarks
0		Ground Surface	76.042								Stickup 0.76m Water level 15/05/00
0		**TOP SOIL** Sandy silt trace gravel, moist.									
5 ft		**SANDY SILT** brown, some grey/black staining, wet	74.164								
7 ft		**SILTY CLAY** redish brown, with grey/black staining, wet	73.68								Pipe 3.2 cm. dia. Pipe pushed into place. No sand pack Concrete seal at surface
		End of Borehole									

Drilled By: Sonic Soil Sampling Inc.

Drill Method: Pionjar 120

Drill Date: May 10, 2000

Vapour Unit: eppm

Dillon Consulting Limited
1425 Bishop Street
Cambridge, Ontario, N1R 6J9
(519) 623-6761

Hole Size: 5.0 cm (2 inches)

Datum: metres above sea level

Sheet: 1 of 1

Top of Pipe: 76.80

Project No: 00-7447

Project: Rennie Street Landfill Investigation

Client: Region of Hamilton Wentworth

Location: Rennie Street Landfill

Borehole ID: MW6-53B

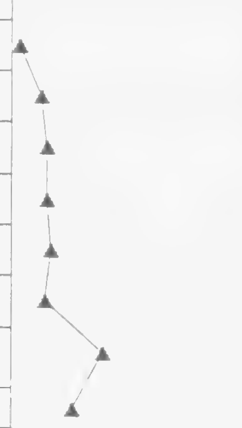
Enclosure: 1

Supervised By: MLG

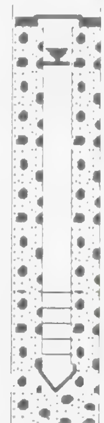
DILLON CONSULTING

Depth (m)	Description	Elevation	Number	Type	Recovery %	Blow Count	Remarks
0	Ground Surface	76.042					
0–1.4	***TOP SOIL*** Sandy silt trace gravel, moist.		1	SS	6	-	Stickup 0.80m Water level 15/05/00
			2	SS	100	-	
1.4–2.1	***SANDY SILT*** brown, some grey/black staining, wet	74.164	3	SS	100	-	
2.1–3.4	***SILTY CLAY*** red-brown, with grey/black staining, wet		4	SS	100	-	Pipe 3.2 cm. dia. Pipe pushed into place. No sand pack Concrete seal at surface
3.4–6.1	***SHALE*** weathered, damp, reddish brown, generally weathered to a silty sand with some portions being redish brown clay.	72.64	5	SS	100	-	
			6	SS	100	-	
			7	SS	100	-	
		69.946	8	SS	83		
	End of Borehole						

ORGANIC VAPOUR: ● %LEL 25 50 75; ▲ ppm 100 200 300



Well Data



Drilled By: Sonic Soil Sampling Inc.
Drill Method: Pionjar 120
Drill Date: May 10, 2000
Vapour Unit: eppm

Dillon Consulting Limited
1425 Bishop Street
Cambridge, Ontario, N1R 6J9
(519) 623-6761

Hole Size: 5.0 cm (2 inches)
Datum: metres above sea level
Sheet: 1 of 1
Top of Pipe: 76.837

Project No: 00-7447

Project: Rennie Street Landfill Investigation

Client: Region of Hamilton Wentworth

Location: Rennie Street Landfill

Borehole ID: BH6-54

Enclosure: 1

Supervised By: MLG

DILLON CONSULTING

SUBSURFACE PROFILE				SAMPLE DATA					ORGANIC VAPOUR ● %LEL 25 50 75 / ▲ ppm 100 200 300	Well Data	Remarks
Depth (ft / m)	Symbol	Description	Elevation	Number	Type	Sample	Recovery %	Blow Count			
0 / 0		Ground Surface	80.2								
0–5.5 ft		*FILL* brown clayey silt with trace sand, contains asphalt and concrete.		1	SS		80	-	▲		
				2	SS		13	-	▲		
		becoming wet	78.524								
5.5–10.5 ft		*SANDY SILT* brown, with some gravel, wet		3	SS		67	-	▲		
				4	SS		50	-	▲		
			77	5	SS		40	-	▲		
10.5–11 ft		*SAND* brown, with some silt and gravel, saturated	76.847								
		End of Borehole									

Drilled By: Sonic Soil Sampling Inc.

Drill Method: Pionjar 120

Drill Date: May 11, 2000

Vapour Unit: eppm

Dillon Consulting Limited
1425 Bishop Street
Cambridge, Ontario, N1R 6J9
(519) 623-6761

Hole Size: 5.0 cm (2 inches)

Datum: metres above sea level

Sheet: 1 of 1

Top of Pipe: N/A

Project No: 00-7447

Project: Rennie Street Landfill Investigation

Client: Region of Hamilton Wentworth

Location: Rennie Street Landfill

Borehole ID: BH6-55

Enclosure: 1

Supervised By: MLG

DILLON CONSULTING

SUBSURFACE PROFILE				SAMPLE DATA					ORGANIC VAPOUR	Well Data	Remarks
Depth (ft / m)	Symbol	Description	Elevation	Number	Type	Sample	Recovery %	Blow Count	%LEL 25 50 75 / ppm 100 200 300		
0 / 0		Ground Surface	83.016								
		TOP SOIL									
		FILL reddish brown clay with trace gravel, to sandy silt, contains asphalt and glass debris.		1	SS		50	-			
				2	SS		80	-			
		sample = wet for 1.5 - 1.8 m below which it becomes damp due to higher silt content									
				3	SS		100	-			
		becoming saturated	80.349	4	SS		53	-			
		End of Borehole									

Drilled By: Sonic Soil Sampling Inc.

Drill Method: Pionjar 120

Drill Date: May 11, 2000

Vapour Unit: eppm

Dillon Consulting Limited
1425 Bishop Street
Cambridge, Ontario, N1R 6J9
(519) 623-6761

Hole Size: 5.0 cm (2 inches)

Datum: metres above sea level

Sheet: 1 of 1

Top of Pipe: N/A

Project No: 00-7447

Project: Rennie Street Landfill Investigation

Client: Region of Hamilton Wentworth

Location: Rennie Street Landfill

Borehole ID: BH6-56

Enclosure: 1

Supervised By: MLG

DILLON CONSULTING

SUBSURFACE PROFILE				SAMPLE DATA					ORGANIC VAPOUR %LEL 25 50 75 / ppm 100 200 300	Well Data	Remarks
Depth (ft / m)	Symbol	Description	Elevation	Number	Type	Sample	Recovery %	Blow Count			
0		Ground Surface	82.943								
0 – 5.8 ft		***FILL*** reddish brown clayey silt, trace gravel contains asphalt debris		1	SS		80	-			
				2	SS		100	-			
			81.166								
5.8 – 12.2 ft		***WASTE*** black, damp to wet, glass paper, metal and cardboard.		3	SS		100	-			
				4	SS		50	-			
			79 209	5	SS		20	-			
		End of Borehole									

Drilled By: Sonic Soil Sampling Inc.
Drill Method: Pionjar 120
Drill Date: May 11, 2000
Vapour Unit: eppm

Dillon Consulting Limited
1425 Bishop Street
Cambridge, Ontario, N1R 6J9
(519) 623-6761

Hole Size: 5.0 cm (2 inches)
Datum: metres above sea level
Sheet: 1 of 1
Top of Pipe: N/A

Project No: 00-7447	**Borehole ID: MW6-57**
Project: Rennie Street Landfill Investigation	
Client: Region of Hamilton Wentworth	**Enclosure:** 1
Location: Rennie Street Landfill	**Supervised By:** MLG

DILLON CONSULTING

Depth (m)	Description	Elevation	Number	Type	Recovery %	Blow Count	Remarks
0	Ground Surface	83.56					
	TOP SOIL brown silty sand, trace gravel	83.408					Stickup 1.03m
	SILTY CLAY reddish brown, trace gravel, dry		1	SS	50	-	
			2	SS	80	-	15/05/00
		81.731					
	SHALE weathered, damp, reddish brown, generally weathered to silty sand with some portions being silty clay.		3	SS	80	-	Pipe 3.2 cm. dia. Pipe pushed into place. No sand pack Water level
			4	SS	80	-	
		80.36	5	SS	20	-	
	End of Borehole						

ORGANIC VAPOUR: %LEL 25 50 75; ppm 100 200 300

Drilled By: Sonic Soil Sampling Inc.	**Dillon Consulting Limited**	Hole Size: 5.0 cm (2 inches)
Drill Method: Pionjar 120	**1425 Bishop Street**	Datum: metres above sea level
Drill Date: May 12, 2000	**Cambridge, Ontario, N1R 6J9**	Sheet: 1 of 1
Vapour Unit: eppm	**(519) 623-6761**	Top of Pipe: 84.594

Project No: 00-7447

Project: Rennie Street Landfill Investigation

Client: Region of Hamilton Wentworth

Location: Rennie Street Landfill

Borehole ID: MW6-58A

Enclosure: 1

Supervised By: MLG

DILLON CONSULTING

Depth (m)	Symbol	Description	Elevation	Number	Type	Sample	Recovery %	Blow Count	Organic Vapour (%LEL 25 50 75; ppm 100 200 300)	Well Data	Remarks
0		Ground Surface	83.648								Stickup 0.74 m
0–1.73		**FILL** Sand and gravel mixed with some grey slag like material and brick debris, dry, becoming a reddish brown / grey sandy silt	81.92								Water level on 07/06/00
1.73–3.66		**SANDY SILT** Reddish brown, dry, mottled with some grey colouring at 1.5 to 2.1 m. Weathered shale fragments observed at 3.05 m.	79.99								
3.66–3.96		**SHALE (WEATHERED)** Red / grey some voids and fractured sections.	79.686								
		End of Borehole									

Drilled By: Atcost Soil Drilling Inc.

Drill Method: Hollow Stem Augers/ HQ cores

Drill Date: July 5, 2000

Vapour Unit: eppm

Dillon Consulting Limited
1425 Bishop Street
Cambridge, Ontario, N1R 6J9
(519) 623-6761

Hole Size: Cored Hole 7.62cm

Datum: metres above sea level

Sheet: 1 of 1

Top of Pipe:

Project No: 00-7447

Project: Rennie Street Landfill Investigation

Client: Region of Hamilton Wentworth

Location: Rennie Street Landfill

Borehole ID: MW6-58B

Enclosure: 1

Supervised By: MLG

DILLON CONSULTING

SUBSURFACE PROFILE

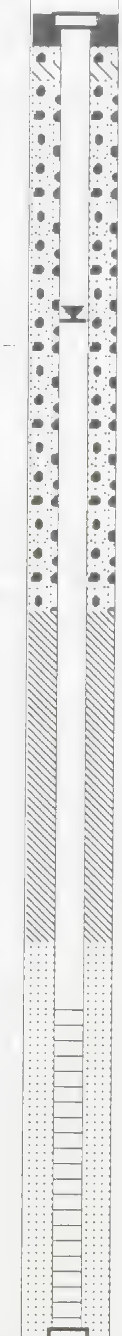
Depth (m)	Description	Elevation
0	Ground Surface	83.664
0 – 1.7	***FILL*** Sand and gravel mixed with some grey slag like material and some brick debris, dry. Becoming a reddish brown/ grey sandy silt, dry.	81.936
1.7 – 3.6	***SANDY SILT*** Reddish brown, dry, mottled with some grey colouring at 1.5 to 2.1 m. Weathered shale fragments observed at 3.05 m.	80.037
3.6 – 4.6	***SHALE (WEATHERED)*** Weathered, reddish-brown generally weathered to silty sand.	79.092
4.6 – 12.2	***SHALE*** Red / grey some voids and fractured sections. Oxidation visible in some fractures at 4.8 m. Calcite precipitate visible in voids and fractures	71.472

SAMPLE DATA

Number	Type	Recovery %	Blow Count
1	SS	42	18
2	SS	33	7
3	SS	80	27
4	SS	80	31
5	SS	67	50
1	CS	80	-
2	CS	64	-
3	CS	89	-
4	SS	78	-
5	SS	86	-

ORGANIC VAPOUR

Well Data



Remarks

Stickup 0.6 m

Water level on 07/06/00

Pipe diameter 1 inch

Augered to 4.6 m, cored below that depth

Drilled By: Atcost Soil Drilling Inc.
Drill Method: Hollow Stem Augers/ HQ cores
Drill Date: July 5, 2000
Vapour Unit: eppm

Dillon Consulting Limited
1425 Bishop Street
Cambridge, Ontario, N1R 6J9
(519) 623-6761

Hole Size: Cored Hole 7.62cm
Datum: metres above sea level
Sheet: 1 of 1
Top of Pipe:

Project No: 00-7447

Project: Rennie Street Landfill Investigation

Client: Region of Hamilton Wentworth

Location: Rennie Street Landfill

Borehole ID: MW6-59

Enclosure: 1

Supervised By: MLG

DILLON CONSULTING

Depth (m)	Description	Elevation	Number	Type	Recovery %	Blow Count	Remarks
0	Ground Surface	83.054					
0–1.92	*FILL* Sand and Gravel mixed with some grey slag like material, dry. Becoming wet reddish brown silty clay at 0.76 m with some organic soil/ debris.	81.134	1	SS	63	31	Stickdown 0.17 m
			2	SS	67	5	Water level on 07/06/00
			3	SS	63	15	
1.92–4.57	*WASTE* Black stained, containing wood, paper, plastic, some metal, some glass and possible recycled roofing material, refuse odour.	78.482	4	SS	33	4	
			5	SS	50	6	
			6	SS	33	8	
4.57–5.18	*SHALE (WEATHERED)* Weathered reddish brown, wet, generally weathered to silty sand with some portions being clayey silt.	77.872	7	SS	17	50	
	End of Borehole						

Organic Vapour: %LEL 25, 50, 75; ppm 100, 200, 300

Drilled By: Atcost Soil Drilling Inc.

Drill Method: Hollow Stem Augers

Drill Date: July 5, 2000

Vapour Unit: eppm

Dillon Consulting Limited
1425 Bishop Street
Cambridge, Ontario, N1R 6J9
(519) 623-6761

Hole Size: 21.6 cm (8.5 inch)

Datum: metres above sea level

Sheet: 1 of 1

Top of Pipe: 85.63

Project No: 00-7447

Project: Rennie Street Landfill Investigation

Client: Region of Hamilton Wentworth

Location: Rennie Street Landfill

Borehole ID: MW6-60

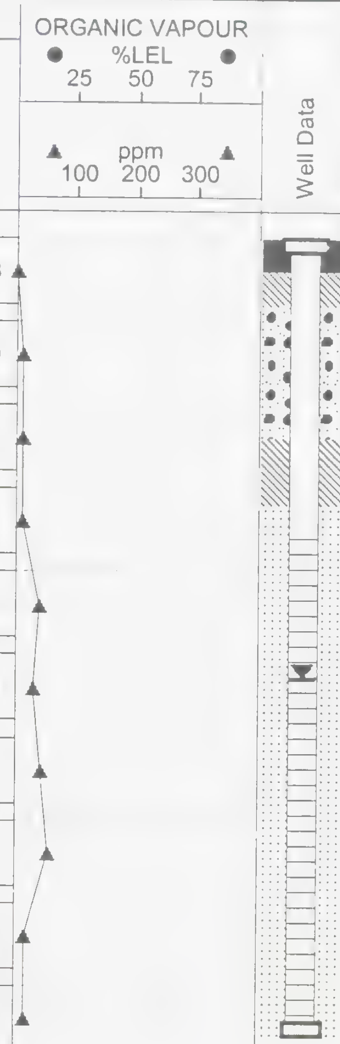
Enclosure: 1

Supervised By: MLG

DILLON CONSULTING

Depth (m)	Description	Elevation	Number	Type	Recovery %	Blow Count	Remarks
0	Ground Surface	84.066					
0–1.52	**FILL** Sand and gravel, brown, moist, mixed with some old asphalt, brick and organic debris, some reddish brown sandy silt throughout.	82.542	1	SS	12	28	Stickdown 0.1 m
			2	SS	75	10	
1.52–6.1	**SANDY SILT** Reddish brown with some gravel, uniform, moist, no odour	77.97	3	SS	71	6	bentonite seal
			4	SS	92	5	
			5	SS	75	4	
			6	SS	79	3	Water level on 07/06/00
			7	SS	66	6	
			8	SS	80	5	
6.1–7.47	**SHALE (WEATHERED)** Weathered, moist reddish brown, generally weathered to silty sand with sime portions being clayey silt.	76.598	9	SS	75	29	
			10	SS	50	80	
	End of Borehole						

ORGANIC VAPOUR



Drilled By: Atcost Soil Drilling Inc.

Drill Method: Hollow Stem Augers

Drill Date: July 4, 2000

Vapour Unit: eppm

Dillon Consulting Limited
1425 Bishop Street
Cambridge, Ontario, N1R 6J9
(519) 623-6761

Hole Size: 21.6 cm (8.5 inch)

Datum: metres above sea level

Sheet: 1 of 1

Top of Pipe:

Project No: 00-7447

Project: Rennie Street Landfill Investigation

Client: Region of Hamilton Wentworth

Location: Hamilton X Palette Company

Borehole ID: MW6-61

Enclosure: 1

Supervised By: MLG

DILLON CONSULTING

Depth (ft)	Depth (m)	Description	Elevation	Number	Type	Recovery %	Blow Count	Remarks
0	0	Ground Surface	82.708					
0–7.5	0–2.3	*FILL* Sand and gravel, turning to moist red sandy silt containing brick, pottery and glass debris.	80.422	1	SS	8	24	Stickdown0.14m
				2	SS	33	7	Water level on 07/06/00
				3	SS	8	3	
7.5–20	2.3–6.1	*WASTE* Black sandy silty, damp to wet, contains paper, plastic, wood, and rubber debris, refuse odour.	76.612	4	SS	8	2	
				5	SS	13	4	
				6	SS	42	4	
				7	SS	25	7	
				8	SS	29	4	
20–22	6.1–6.7	*CLAYEY SILT* Reddish brown, moist	76.002	9	SS	63	12	
		End of Borehole						

Organic Vapour: %LEL 25 50 75; ppm 100 200 300

Drilled By: Atcost Soil Drilling Inc.

Drill Method: Hollow Stem Augers

Drill Date: July 4, 2000

Vapour Unit: eppm

Dillon Consulting Limited
1425 Bishop Street
Cambridge, Ontario, N1R 6J9
(519) 623-6761

Hole Size: 21.6 cm (8.5 inch)

Datum: metres above sea level

Sheet: 1 of 1

Top of Pipe:

Project No: 00-7447

Project: Rennie Street Landfill Investigation

Client: Region of Hamilton Wentworth

Location: Hamilton X Palette Company

Borehole ID: BH6-62

Enclosure: 1

Supervised By: MLG

DILLON CONSULTING

Depth (ft / m)	Symbol	Description	Elevation	Number	Type	Sample	Recovery %	Blow Count	Organic Vapour (%LEL 25 50 75; ppm 100 200 300)	Well Data	Remarks
0 ft / 0 m		Ground Surface	83.186								
0–7 ft		***FILL*** Sand and gravel, mixed with brick debris, turning to brown sandy silt containing some brick, and metals debris.	81.052	1	SS		25	9			
				2	SS		42	3			
				3	SS		0	50			
7–12 ft		***SANDY SILT*** Reddish brown trace gravel.	79.548	4	SS		33	83			
				5	SS		21	50			
		End of Borehole									

Drilled By: Atcost Soil Drilling Inc.

Drill Method: Hollow Stem Augers

Drill Date: July 4, 2000

Vapour Unit: eppm

Dillon Consulting Limited
1425 Bishop Street
Cambridge, Ontario, N1R 6J9
(519) 623-6761

Hole Size: 21.6 cm (8.5 inch)

Datum: metres above sea level

Sheet: 1 of 1

Top of Pipe:

Project No: 00-7447
Project: Rennie Street Landfill Investigation
Client: Region of Hamilton Wentworth
Location: Rennie Street Landfill

Borehole ID: MW6-63

Enclosure: 1
Supervised By: MLG

DILLON CONSULTING

Depth (ft / m)	Symbol	Description	Elevation	Number	Type	Sample	Recovery %	Blow Count	Organic Vapour (%LEL 25 50 75; ppm 100 200 300)	Well Data	Remarks
0 / 0		Ground Surface	83.28								
		TOPSOIL Brown sandy silt									
1		**SANDY SILT** Reddish brown, uniform, trace gravel, dry		1	SS		40				Stickdown 0.11m
3 / 1			82.189	2	SS		50				Dry 07/12/00
4		**SHALE (WEATHERED)** Weathered reddish brown, wet, generally weathered to silty sand with some grey layers.	81.756	3	SS		20				
5		End of Borehole									

Drilled By: Sonic Soil Sampling Inc.
Drill Method: Pionjar
Drill Date: July 11, 2000
Vapour Unit: eppm

Dillon Consulting Limited
1425 Bishop Street
Cambridge, Ontario, N1R 6J9
(519) 623-6761

Hole Size: 5 cm (2 inch)
Datum: metres above sea level
Sheet: 1 of 1
Top of Pipe:

Project No: 00-7447

Project: Rennie Street Landfill Investigation

Client: Region of Hamilton Wentworth

Location: Rennie Street Landfill

Borehole ID: MW6-64

Enclosure: 1

Supervised By: MLG

DILLON CONSULTING

SUBSURFACE PROFILE				SAMPLE DATA					ORGANIC VAPOUR	Well Data	Remarks
Depth	Symbol	Description	Elevation	Number	Type	Sample	Recovery %	Blow Count	%LEL 25 50 75 / ppm 100 200 300		
0 ft / 0 m		Ground Surface	83.27								
		TOPSOIL Brown sandy silt	83.118								
		SANDY SILT Brown, trace gravel,	82.904	1	SS		73				Stickdown 0.1 m
		SILT Reddish brown mottled, trace clay, moist.	82.154	2	SS		77				Dry 07/12/00
		SHALE (WEATHERED) Weathered reddish brown, wet, generally weathered to silty sand with some grey layers.	81.746	3	SS		100				
				4	SS		100				
		End of Borehole									

Depth scale: ft 0–16; m 0–5

Drilled By: Sonic Soil Sampling Inc.
Drill Method: Pionjar
Drill Date: July 11, 2000
Vapour Unit: eppm

Dillon Consulting Limited
1425 Bishop Street
Cambridge, Ontario, N1R 6J9
(519) 623-6761

Hole Size: 5 cm (2 inch)
Datum: metres above sea level
Sheet: 1 of 1
Top of Pipe:

Project No: 00-7447

Project: Rennie Street Landfill Investigation

Client: Region of Hamilton Wentworth

Location: Rennie Street Landfill

Borehole ID: MW6-65

Enclosure: 1

Supervised By: MLG

DILLON CONSULTING

Depth (ft)	Depth (m)	Description	Elevation	Number	Type	Recovery %	Blow Count	Organic Vapour (ppm)	Remarks
0	0	Ground Surface	83.874						
		TOPSOIL Brown sandy silt	83.621						Stickdown 0.08
		SLAG FILL Grey slag like material.	83.112	1	SS	67			
		SILT Reddish brown, trace shale fragments, dry.	82.655	2	SS	83			Dry 07/12/00
		SHALE (WEATHERED) Weathered reddish brown, wet, generally weathered to silty sand with some grey layers.	82.35	3	SS	50			
		End of Borehole							

Organic Vapour: %LEL 25 50 75; ppm 100 200 300

Drilled By: Sonic Soil Sampling Inc.

Drill Method: Pionjar

Drill Date: July 11, 2000

Vapour Unit: eppm

Dillon Consulting Limited
1425 Bishop Street
Cambridge, Ontario, N1R 6J9
(519) 623-6761

Hole Size: 5 cm (2 inch)

Datum: metres above sea level

Sheet: 1 of 1

Top of Pipe:

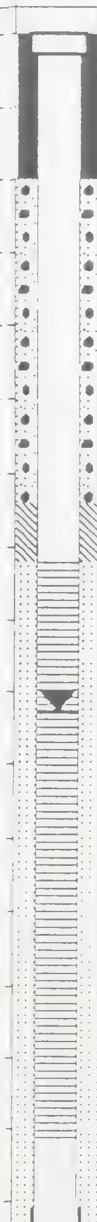
Project No: 99-6854
Project: PCB SEEP REMEDIATION
Client: CITY OF HAMILTON
Location: RENNIE STREET LANDFILL

Borehole ID: PW6-1

Enclosure: MONUMENT CASING
Supervised By: TJJ/IJH

DILLON CONSULTING

SUBSURFACE PROFILE			SAMPLE DATA					ORGANIC VAPOUR %LEL 25 50 75 / ppm 100 200 300	Well Data	Remarks
Depth (ft / m)	Description	Elevation	Number	Type	Sample	Recovery %	Blow Count			
0 ft / 0 m	Ground Surface	0								
0–5 ft	***FILL*** Sand and gravel Brown, some silty clay, dry to moist rubber present	-1.524	1	ES		n/a	-			
5–10 ft	***WASTE*** Black, moist Wood, plastic, rubber, glass		2	ES		n/a	-			
10–15 ft			3	ES		n/a	-			
15–20 ft	ball of metal wire		4	ES		n/a	-			
20–25 ft	30 cm of 1/4" hydraulic line Becoming wet		5	ES		n/a	-			
25–30 ft			6	ES		n/a	-			
30–35 ft			7	ES		n/a	-			
35–40 ft		-11.582	8	ES		n/a	-			
38–40 ft	***Silty Clay*** Grey, moist, soft	-12.192								
40 ft	End of Borehole									



Drilled By: Atcost Soil Drilling	**Dillon Consulting Limited**	Hole Size: 10"
Drill Method: Truck Mounted CME 75	**1425 Bishop Street**	Datum:
Drill Date: October 14, 1999	**Cambridge, Ontario, N1R 6J9**	Sheet: 1 of 1
Vapour Unit: ppm	**(519) 623-6761**	Top of Pipe:

DILLON

PROJECT No.	96-3564-26-06	BOREHOLE No.	GW1
DATUM:		Sheet	1 of 1

PROJECT:	RED HILL CREEK	DATE:	9 October 1998
LOCATION:	HAMILTON	INSPECTOR:	ADD

DEPTH (m)	ELEV. DEPTH (m)	SYMBOLIC LOG	DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE BLOW CNT	SAMPLE %RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/) 20 40 60 80; Vapour (ppm) (*) 100 200 300 400	MONITOR INSTALLATION DETAILS GW1
			FILL Sand and Gravel Brown, dry, loose, poorly sorted. Cobbles and debris present.								
1						EZ					
	1.5		SHALE Red, soft, layered.								
2											
	2.1		2.13m - End of borehole Notes: (1) Monitoring well constructed of 50mm diameter, Sch. 40, flush-threaded, PVC riser with a 1.52m long, No. 10 slot well screen.								
3											
4											

DILLON

PROJECT No.	96-3564-26-06	BOREHOLE No.	GW2
DATUM:		Sheet	1 of 1
PROJECT:	RED HILL CREEK	DATE:	9 October 1998
LOCATION:	HAMILTON	INSPECTOR:	ADD

DEPTH (m)	ELEV. DEPTH (m)	SYMBOLIC LOG	DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE BLOW CNT	SAMPLE %RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/) 20 40 60 80 / Vapour (ppm) (*) 100 200 300 400	MONITOR INSTALLATION DETAILS GW2
			FILL Sand and Gravel Brown, dry, loose, poorly sorted.								
	0.6		SHALE Red, soft, layered. 0.60 to 1.80m - Weathered to clayey silt.			EZ					
1											
2											
	2.4		2.44m - End of borehole Notes: (1) Monitoring well constructed of 50mm diameter, Sch. 40, flush-threaded, PVC riser with a 1.52m long, No. 10 slot well screen.								
3											
4											

DILLON

PROJECT No. 96-3564-26-06
DATUM:

BOREHOLE No. GW3
Sheet 1 of 1

PROJECT: RED HILL CREEK
LOCATION: HAMILTON

DATE: 9 October 1998
INSPECTOR: ADD

DEPTH (m)	ELEV. DEPTH (m)	SYMBOLIC LOG	DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE BLOW CNT	SAMPLE %RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/) 20 40 60 80 / Vapour (*) (ppm) 100 200 300 400	MONITOR INSTALLATION DETAILS GW3
			ASPHALT								
	0.1		SAND Black, dry, loose, medium grained, some gravel, poorly sorted. Slight to mild hydrocarbon odour.								
1											
	1.2		SHALE Red, soft, layered. 1.20 to 1.80m - Weathered to clayey silt.			EZ					
2											
	2.7		2.74m - End of borehole Notes: (1) Monitoring well constructed of 50mm diameter, Sch. 40, flush-threaded, PVC riser with a 1.52m long, No. 10 slot well screen.								
3											
4											

DILLON

PROJECT No.	96-3564-26-06	BOREHOLE No.	GW4
DATUM:		Sheet 1 of 1	
PROJECT:	RED HILL CREEK	DATE:	9 October 1998
LOCATION:	HAMILTON	INSPECTOR:	ADD

DEPTH (m)	ELEV. DEPTH (m)	SYMBOLIC LOG	DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE BLOW CNT	SAMPLE %RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/) 20 40 60 80 / Vapour (*) (ppm) 100 200 300 400	MONITOR INSTALLATION DETAILS GW4
			ASPHALT								
	0.1		FILL Sand and Gravel Brown, dry, loose, poorly sorted.								
1	0.6		SHALE Red, soft, layered.			EZ					
2											
3	2.7		2.74m - End of borehole Notes: (1) Monitoring well constructed of 50mm diameter, Sch. 40, flush-threaded, PVC riser with a 1.52m long, No. 10 slot well screen.								
4											

DILLON

PROJECT No.	96-3564-26-06	BOREHOLE No.	GW5
DATUM:		Sheet	1 of 1
PROJECT:	RED HILL CREEK	DATE:	9 October 1998
LOCATION:	HAMILTON	INSPECTOR:	ADD

DEPTH (m)	ELEV. DEPTH (m)	SYMBOLIC LOG	DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE BLOW CNT	SAMPLE %RECOVERY	LABORATORY ANALYSIS	N VALUE (□) (Blows/) 20 40 60 80 / Vapour (ppm) (*) 100 200 300 400	MONITOR INSTALLATION DETAILS GW5
			SAND Brown, dry, loose, medium grained well sorted.								
1	1.2		SHALE Red, soft, layered.			EZ					
2	2.7		2.74m - End of borehole Notes: (1) Monitoring well constructed of 50mm diameter, Sch. 40, flush-threaded, PVC riser with a 1.52m long, No. 10 slot well screen.								
3											
4											

DILLON	PROJECT No. 96-3564-26-06	BOREHOLE No. GW6
	DATUM:	Sheet 1 of 1

PROJECT:	RED HILL CREEK	DATE: 9 October 1998
LOCATION:	HAMILTON	INSPECTOR: ADD

DEPTH (m)	ELEV. DEPTH (m)	SYMBOLIC LOG	DESCRIPTION	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE TYPE	SAMPLE BLOW CNT	SAMPLE %RECOVERY	LABORATORY ANALYSIS	N VALUE (○) (Blows/) 20 40 60 80; Vapour (×) (ppm) 100 200 300 400	MONITOR INSTALLATION DETAILS GW6
			FILL Sand and Gravel Brown, dry, loose. Moderate unidentified odour.								
1						EZ					
2	1.8		SHALE Red, soft, layered. 1.80 to 2.40m - Weathered to clayey silt.								
3	2.7		2.74m - End of borehole Notes: (1) Monitoring well constructed of 50mm diameter, Sch. 40, flush-threaded, PVC riser with a 1.52m long, No. 10 slot well screen.								
4											

Project No: 00-7447

Project: Rennie Street Landfill Investigation

Client: Region of Hamilton Wentworth

Location: Rennie Street Landfill

Borehole ID: GW7

Enclosure: 1

Supervised By: MLG

DILLON
CONSULTING

SUBSURFACE PROFILE				SAMPLE DATA					ORGANIC VAPOUR	Well Data	Remarks
Depth (ft / m)	Symbol	Description	Elevation	Number	Type	Sample	Recovery %	Blow Count	%LEL 25 50 75 / ppm 100 200 300		
0 / 0		Ground Surface	81 948								Stickup 0.34m
0–10 ft / 0–3 m		*FILL* brown sandy silt with gravel, asphalt, and brick debris		1	SS		50	-			Bentonite seal
				2	SS		83	-			
				3	SS		73	-			
				4	SS		74	-			Water level 15/05/00
10 ft / 3 m		*WASTE* Dark black material covered in dark black viscous liquid, strong odour.	78 9	5	SS		67	-			Pipe 3.2 cm. dia. Pipe pushed into place.
			77 833	6	SS		60	-			
		CLAY reddish brown, moist	77 681								
		End of Borehole									

Drilled By: Sonic Soil Sampling Inc.
Drill Method: Pionjar 120
Drill Date: May 10, 2000
Vapour Unit: eppm

Dillon Consulting Limited
1425 Bishop Street
Cambridge, Ontario, N1R 6J9
(519) 623-6761

Hole Size: 5.0 cm (2 inches)
Datum: metres above sea level
Sheet: 1 of 1
Top of Pipe: 82.288

TEST PIT LOGS

Log № TP1 Date: October 8,1998 Inspector: Sean Salvatori Location: Rennie Street Landfill		
Description	**Depth Interval (m)**	Sample №
GRAVEL AND ASPHALT. Dark grey to black, moist, compact, well sorted. Water seeping into test pit at 0.15 m	0.0 - 0.15	
CLAY. Reddish brown, wet, loose, debris present. Debris included cement, metal, brick.	0.15 - 3.12	
End of test pit.	3.12	

Log № TP2 Date: October 8,1998 Inspector: Sean Salvatori Location: Rennie Street Landfill		
Description	**Depth Interval (m)**	Sample №
GRAVEL AND SAND. Grey to black, moist, loose.	0.0 - 0.10	
SALT LAYER. White, dry, compact.	0.10 - 0.15	
GRAVEL AND SAND. Dark brown, dry, hard.	0.15 - 0.38	
CLAY. Brown, moist, stiff, some sand noted, debris present. Debris included wire, rubber, cement.	0.38 - 2.74	
Test pit terminated at bedrock surface.	2.74	

Log № TP3 Date: October 8,1998 Inspector: Sean Salvatori		
Location: Rennie Street Landfill		
Description	**Depth Interval (m)**	**Sample №**
GRAVEL. Grey, dry, loose.	0.0 - 0.08	
CLAY. Reddish brown, moist, stiff.	0.08 - 0.46	
CLAY. Reddish brown, moist, stiff, debris present. Debris included bricks, cement slabs.	0.46 - 1.37	
WASTE. Black, moist, waste present. Waste included plastic, rags, newspaper, wire, string. Strong odour detected.	1.37 - 2.29	
End of test pit.	2.29	

Log № TP4 Date: October 8,1998 Inspector: Sean Salvatori		
Location: Rennie Street Landfill		
Description	**Depth Interval (m)**	**Sample №**
SAND AND GRAVEL. Brown, dry, loose.	0.0 - 0.08	
CLAY WITH SAND. Reddish brown, moist, compact, debris present. Debris included brick, asphalt pieces.	0.08 - 1.83	
CLAY. Greyish blue, dry, compact.	1.83 - 2.44	
CLAY WITH SAND. Reddish brown, moist, compact.	2.44 - 2.98	
End of test pit.	2.98	

Log Nº TP5 Date: October 8,1998 Inspector: Sean Salvatori

Location: Rennie Street Landfill

Description	Depth Interval (m)	Sample Nº
SAND AND GRAVEL. Brown to black, dry, compact.	0.0 - 0.10	
SAND AND GRAVEL. Grey, dry, compact.	0.10 - 0.69	
CLAY. Red, moist, dense.	0.69 - 0.54	
CLAY. Dark brown, moist, dense, debris present. Debris included rubber, wood, wire, string.	0.54 - 1.22	
CLAY. Red, dry, dense.	1.22 - 1.60	
SHALE. Red, dry, weathered shale.	1.60 - 2.29	
LIMESTONE. Greenish grey, dry, weathered.	2.29 - 2.82	
Test pit terminated at bedrock surface.	2.82	

Log Nº TP6 Date: October 8,1998 Inspector: Sean Salvatori

Location: Rennie Street Landfill

Description	Depth Interval (m)	Sample Nº
GRAVEL. Grey, dry, loose.	0.0 - 0.15	
CEMENT FOUNDATION	0.15	
Test pit terminated at foundation surface.	0.15	

Log Nº TP7 Date: October 8,1998 Inspector: Sean Salvatori

Location: Rennie Street Landfill

Description	Depth Interval (m)	Sample Nº
GRAVEL. Grey, dry, loose.	0.0 - 0.15	
CEMENT FOUNDATION	0.15	
Test pit terminated at foundation surface.	0.15	

Log Nº TP8 Date: October 8,1998 Inspector: Sean Salvatori

Location: Rennie Street Landfill

Description	Depth Interval (m)	Sample Nº
SAND AND GRAVEL. Dark brown, dry, compact, some clay, debris present. Debris included large rocks, cement, wood.	0.0 - 1.22	
CLAY. Red, dry, hard.	1.22- 1.37	
SHALE. Red, dry, highly weather shale.	1.37 - 2.59	
Test pit terminated at bedrock surface.	2.59	

Log Nº TP9 Date: October 8,1998	Inspector: Sean Salvatori	
Location: Rennie Street Landfill		
Description	**Depth Interval (m)**	Sample Nº
GRAVEL. Grey, dry, loose, some sand, rootlets and grass present.	0.0 - 0.15	
SAND AND GRAVEL. Brown, dry, compact, debris present. Debris included brick.	0.15 - 0.91	
CLAY. Brown, dry, dense.	0.91 - 1.52	
CLAY. Red, dry, dense.	1.52 - 2.13	
SHALE. Red, dry, weather.	2.13 - 2.74	
Test pit terminated at bedrock surface.	2.74	

Log Nº TP10 Date: October 8,1998	Inspector: Sean Salvatori	
Location: Rennie Street Landfill		
Description	**Depth Interval (m)**	Sample Nº
GRAVEL AND SAND. Brown to black, dry, loose.	0.0 - 0.15	
CLAY. Brown to black, moist, firm, debris present. Debris included bricks, cement, metal. Slight hydrocarbon odour detected.	0.15 - 0.91	
WASTE. Black, moist, waste present. Waste included paper, bottles, jars, cardboard, metal.	0.91 - 1.83	
End of test pit.	1.83	

Log № TP11 Date: October 8,1998	Inspector: Sean Salvatori	
Location: Rennie Street Landfill		
Description	**Depth Interval (m)**	**Sample №**
TOPSOIL. Black, moist, soft, rootlets present.	0.0 - 0.10	
SAND. Brown, dry, loose, debris present. Debris included plastic, cement, rubber, bricks, wood.	0.10 - 0.61	
CLAY. Grey, moist, soft, debris present.	0.61 - 1.83	
WASTE. Dark brown, moist, waste present. Waste included newspaper, nylons, plastic, glass, rags. Strong odour detected.	1.83 - 2.13	
End of test pit.	2.13	

Log № TP12 Date: October 8,1998	Inspector: Sean Salvatori	
Location: Rennie Street Landfill		
Description	**Depth Interval (m)**	**Sample №**
GRAVEL AND SAND. Dark brown, dry, loose.	0.0 - 0.91	
CLAY. Grey, moist, soft to firm. Native	0.91 - 1.37	
End of test pit	1.37	

Log Nº TP13 Date: October 8,1998 Inspector: Sean Salvatori Location: Rennie Street Landfill		
Description	**Depth Interval (m)**	Sample Nº
SAND AND GRAVEL. Brown, moist, soft, rootlets and grass present.	0.0 - 0.15	
CLAY. Brown, moist, firm.	0.15 - 0.76	
WASTE. Brown, moist, waste present. Waste included paper, plastic bottles, glass, string.	0.76 - 0.91	
End of test pit.	0.91	

Log Nº TP14 Date: October 8,1998 Inspector: Sean Salvatori Location: Rennie Street Landfill		
Description	**Depth Interval (m)**	Sample Nº
SAND AND GRAVEL. Brown, moist, soft, rootlets and grass present.	0.0 - 0.46	
WASTE. Brown, moist, waste, present. Waste included glass, paper, rubber, plastic.	0.46 - 0.76	
End of test pit.	0.76	

Log № TP15 Date: October 8,1998 Inspector: Sean Salvatori Location: Rennie Street Landfill		
Description	**Depth Interval (m)**	**Sample №**
SAND AND GRAVEL. Brown, moist, soft, rootlet and grass present.	0.0 - 0.60	
WASTE. Brown, moist, waste present. Waste included glass jars, rags, papers, bricks, plastic.	0.60 - 0.91	
End of test pit.	0.91	

Log № TP16 Date: October 8,1998 Inspector: Sean Salvatori Location: Rennie Street Landfill		
Description	**Depth Interval (m)**	**Sample №**
SAND AND GRAVEL. Brown, moist, soft, rootlets and grass present.	0.0 - 0.15	
CLAY. Brown, moist, firm.	0.15 - 1.22	
WASTE. Brown, moist, waste present. Waste included plastic, ceramic pieces.	1.22 - 1.37	
End of test pits.	1.37	

Log № TP17 Date: April 25, 2000 Inspector: Ian Judd-Henrey Location: Rennie Street Landfill		
Description	**Depth Interval (m)**	Sample №
SAND AND GRAVEL. Brown, moist, soft, rootlets and grass present.	0.0 - 0.15	
SAND. Brown, variable composition, dry, contains concrete, asphalt and slag.	0.15 - 1.22	
CLAYEY SILT. Black, damp, silt and clay, cinder rich, contains thin seam of waste present south side of test pit.	1.22 - 3.96	
End of test pit. Standing water in bottom (lower 0.1 m)	3.96	

Log № TP18 Date: April 25, 2000 Inspector: Ian Judd-Henrey Location: Rennie Street Landfill		
Description	**Depth Interval (m)**	Sample №
TOPSOIL. Dark brown, dry, soft, rootlets and grass present.	0.0 - 0.10	
SILTY SAND. Brown to reddish brown, variable composition, dry to damp, contains lots of brick (to up 35%) also contains wood, concrete, glass, asphalt and slag.	0.10 - 3.20	
End of test pit. Refusal at concrete slab.	3.2	

Log № TP19 Date: April 25, 2000 Inspector: Ian Judd-Henrey Location: Rennie Street Landfill		
Description	**Depth Interval (m)**	**Sample №**
SAND AND GRAVEL. Brown, moist, soft, rootlets and some grass present.	0.0 - 0.10	
GRAVEL. Brown gravel, dry, with some asphalt present.	0.10 - 1.37	
STONEY TILL. Reddish Brown, dry to wet, stiff, cobble up to 0.15 metres in diameter. Bottom of this unit approaching weathered shale-like appearance.	1.37 - 3.20	
End of test pit. Water slowly flowing into test pit.	3.2	

Log № TP20 Date: April 25, 2000 Inspector: Ian Judd-Henrey Location: Rennie Street Landfill		
Description	**Depth Interval (m)**	**Sample №**
TOPSOIL Dark brown, dry, soft, rootlets and grass present.	0.0 - 0.15	
SAND. Brown to black, variable composition, dry to damp, contains lots of concrete along with some asphalt and wood.	0.15 - 3 05	
WASTE. Black, moist, household waste, contains metal, paper, food and jars, odorous.	3.05 - 4.27	
End of test pit. Water in test pit to ~3.5 metres.	4.27	

Log Nº TP21 Date: April 25, 2000 Inspector: Ian Judd-Henrey Location: Rennie Street Landfill		
Description	**Depth Interval (m)**	Sample Nº
TOPSOIL. Dark brown, organic rich, dry, grassed surface.	0.0 - 0.10	
SILTY SAND. Brown, loam dry, contains some concrete and other debris.	0.10 - 0.31	
SILTY CLAY. Brown to grey, damp to wet, small perched layers.	0.31 - 1.68	
WASTE. Black, odorous moist, contains metal, paper, food and jars.	1.68 - 1.83	
End of test pit.	1.83	

Log Nº TP22 Date: April 25, 2000 Inspector: Ian Judd-Henrey Location: Rennie Street Landfill		
Description	**Depth Interval (m)**	Sample Nº
SAND AND GRAVEL. Brown, organic rich, dry, grassed surface.	0.0 - 0.10	
SILTY SAND. Brown to black, dry, contains significant asphalt and some bricks.	0.10 - 1.52	
TILL. Brown to reddish brown, stone-rich, silty clay matrix, soft, damp to wet.	1.52 - 3.35	
WASTE. Black, burnt, moist, contains metal, paper, and wood.	3.35 - 3.51	
End of test pit.	3.51	

Log № TP23 Date: April 25, 2000 Inspector: Ian Judd-Henrey

Location: Rennie Street Landfill

Description	Depth Interval (m)	Sample №
SILTY SAND. Brown to black, dry, contains some gravel and asphalt.	0.0 - 1.83	
TILL. Brown to reddish brown, stone-rich (up to ~70%), silty clay matrix, hard, damp to saturated at 2.7 metres.	1.83 - 3.66	
End of test pit.	3.66	

Log № TP24 Date: April 25, 2000 Inspector: Ian Judd-Henrey

Location: Rennie Street Landfill

Description	Depth Interval (m)	Sample №
SAND. Brown, contains gravel, silt, bricks and other debris, dry, grassed surface.	0.0 - 0.31	
WASTE. Black, partially burnt, moist to saturated with water perched on top of underlying silty clay till, domestic waste.	0.31 - 1.68	
SILTY CLAY TILL. Grey saturated, variable clast size.	1.68 - 2.74	
End of test pit.	2.74	

Log № TP25 Date: April 25, 2000 Inspector: Ian Judd-Henrey Location: Rennie Street Landfill		
Description	**Depth Interval (m)**	Sample №
SILTY SAND. Brown, contains extensive cinders and ash, also contain bricks and wire.	0.0 - 1.22	
WASTE. Black, damp to moist, burnt domestic waste including wire and tins.	1.22 - 1.45	
SILTY CLAY TILL. Reddish, damp, contains numerous clasts of shale increasing with depth, variable clast size.	1.45 - 2.66	
End of test pit. Terminated at or near bedrock surface.	2.66	

Log № TP26 Date: April 25, 2000 Inspector: Ian Judd-Henrey Location: Rennie Street Landfill		
Description	**Depth Interval (m)**	Sample №
SAND AND GRAVEL. Brown, dry to damp, becoming silty at depth, grassed surface.	0.0 - 0.81	
WASTE. Black, burnt, moist, contains domestic waste including paper, cloth, tin and wire.	0.81 - 0.91	
End of test pit.	0.91	

Log Nº TP27 Date: June 26, 2000 Inspector: M. Graham Location: North End in Compound off Brampton Street		
Description	**Depth Interval (m)**	**Sample Nº**
SILTY SAND AND GRAVEL Brown, moist, becoming darker in colour with some black staining at 0.45 m.	0.0 - 1.21	
WASTE. Black, wet, some industrial waste including bricks, rubber, wood metal, buckets and some plastic. A material resembling ground up roof shingles was present at 1.52 m.	1.22 - 3.58	T.P. 27 - 4' ft. (60 ppm)* T.P. 27 - 5' ft. T.P. 27 - 9' ft. (25 ppm)*
End of test pit. Terminated due to refusal on suspected bedrock	3.58	

Log Nº TP 28 Date: June 26, 2000 Inspector: M. Graham Location: North End of Compound off Brampton Street		
Description	**Depth Interval (m)**	**Sample Nº**
SILTY SAND AND GRAVEL Brown, moist, with some traces of waste including rubber, wood and bricks at 0.3 m.	0.0 - 0.91	
WASTE. Black, wet, some Industrial waste including bricks, rubber, wood (~50%), glass (~20%), metal (~5%), tires and some plastic. An oily sheen was visible on water, sheer became quite prominant at 2.89 m.	0.91 - 3.96	T.P. 28 - 5' ft. (42 ppm)* T.P. 28 - 9.5' ft. (50 ppm)*
CLAY. Red/brown, native	3.96 - 4.27	
End of Test Pit	4.27	

Log № TP29 Date: June 26, 2000 Inspector: M. Graham Location: East of Office		
Description	**Depth Interval (m)**	**Sample №**
SILTY SAND AND GRAVEL Brown, moist, with some brick debris at 0.3 m	0 - 0.91	
WASTE. Black, wet, some Industrial waste including glass, bricks, rubber, wood, metal tires and shoes.	0.91 - 2.43	T.P. 29 - 5' ft. (20 ppm)*
SHALE. Red/brown, weathered.	2.43 - 3.04	
End of Test Pit	3.04	

Log № TP30 Date: June 26, 2000 Inspector: M. Graham Location: Northwest of Office		
Description	**Depth Interval (m)**	**Sample №**
SANDY SILTY CLAY. Slightly moist, native	0 - 1.52	T.P. 30 - 0-5' ft. (40 ppm)*
SHALE. Red/brown, weathered, with a grey layer at about 2.13 m.	1.52 - 2.43	T.P. 30 - 5-8' ft. (30 ppm)*
End of Test Pit	2.43	

Log Nº TP31 Date: June 26, 2000	Inspector: M. Graham	
Location: Middle of Public Work Yard		
Description	**Depth Interval (m)**	**Sample Nº**
FILL. Silty sand and gravel, Brown, moist.	0 - 0.3	
CONCRETE. Grey with some bricks and asphalt debris.	0.3 - 0.61	
WASTE. Black, wet, some industrial waste present including; wood (~50%), glass (~20%), metal. tires (~10%), bricks (~5%), rubber, and copper wire. A slight oily sheen was visible on water. Waste had a strong refuse odour and slight hydrocarbon odour.	0.61 - 3.96	T.P. 31 - 5' ft. (85 ppm)* T.P. 31 - 10' ft. (60 ppm)*
CLAYEY SILT. Red/brown	3.96 - 4.27	
End of Test Pit	4.27	

Log Nº TP32 Date: July 10, 2000	Inspector: M. Graham	
Location: South west corner of site near fence		
Description	**Depth Interval (m)**	**Sample Nº**
TOP SOIL	0 - 0.15	
FILL, clayey silt. red/ brown, mottled with trace gravel. Some industrial waste mixed in after 0.6 m; wood, plastic, metal, cans	0.15 - 2.43	T.P. 32 - 2 - 3' ft (8 ppm)*
RED/BROWN SHALE. Weathered, moist.	2.43 - 2.89	T.P. 32 - 8' ft. (18ppm)*
End of Test pit	2.89	

Log Nº TP33 Date: June 26, 2000 Inspector: M. Graham

Location: Middle of Public Works Yard

Description	Depth Interval (m)	Sample Nº
FILL, silty sand and gravel brown, moist.	0 - 0.3	
CONCRETE. Grey, hard.	0.3 - 0.81	
FILL. Sand black, wet with roots and natural organics, refuse odour.	0.81 - 1.83	T.P. 33 - 5' ft. (350 ppm)*
WASTE. Black, wet, some Industrial waste including wood (~35%), glass (~30%), metal and rubber. Strong refuse odour.	1.83 - 3.65	T.P. 33 - 8' ft. (100 ppm)*
End of Test Pit	3.65	

Log Nº TP34 Date: July 10, 2000 Inspector: M. Graham

Location: South west corner south of chain-link fence

Description	Depth Interval (m)	Sample Nº
TOP SOIL	0 - 0.15	
FILL, clayey silt. Red/ brown, mottled with trace shale fragments, some industrial waste mixed in after 1.52 m; metal (~2%), paper(~2%), glass (~2%), wire(~1%).	0.15 - 2.43	T.P. 34 - 7' ft. (50 ppm)*
RED/BROWN SHALE. Weathered, moist with some grey layers.	2.43 - 2.89	T.P. 34 - 11' ft. (29 ppm)*
End of Test pit	2.89	

Log Nº TP35 Date: July 10, 2000 Inspector: M. Graham Location: Corner of Rennie St and Entrance to yard		
Description	**Depth Interval (m)**	**Sample Nº**
TOP SOIL	0 - 0.10	
FILL, clayey silt. Red/ brown, mottled with trace shale fragments. Grey slag mixed in at 1.2 m. Black slag mixed in at 2.1 m with some industrial waste: glass, metal, and plastic.	0.10 - 3.65	T.P. 35 - 4' ft. (8 ppm)* T.P. 34 - 11' ft. (30 ppm)*
RED/BROWN SHALE. Weathered, with some grey layers, wet at 3.65 m	3.65 - 3.96	
End of Test pit	3.96	

Log N° TP36 Date: July 10, 2000 Inspector: M. Graham Location: In Public Works Yard near Rennie Street Entrance		
Description	**Depth Interval**	**Sample N°**
TOP SOIL	0 - 0.15	
FILL. Sandy silt. Brown mixed with black foundry sand.	0.15 - 0.76	T.P. 36 - 2' ft. (20 ppm)*
FILL. Red / Brown silty clay, trace gravel with some waste; wood (20%), rubber (10%), metal, and brick.	0.76 - 2.13	T.P. 36 - 7' ft. (70 ppm)*
WASTE. Black stained, saturated, strong refuse odour; wood (20%), paper (15%), rubber (10%), plastic (10%), metal, and bottles.	2.13 - 4.26	T.P. 36 - 9' ft. (55 ppm)*
End of Test Pit	4.26	

Log Nº TP37A	Date: June 26, 2000	Inspector: M. Graham
Location: Near the End of Rennie Street (7 m in length running North - South, south of TP-17.		
Description	**Depth Interval (m)**	**Sample Nº**
SAND AND GRAVEL. Brown to dark brown, slightly moist.	0 - 0.22	
CLAYEY SILT. Red/brown with some gravel and shale fragments.	0.22 - 0.91	T.P. 37 - 3' ft. (19 ppm)*
SHALE. (Weathered) Red/brown	0.91 - 1.06m	
End of Test Pit	1.06 m	

Log Nº TP37B	Date: June 26, 2000	Inspector: M. Graham
Location: Near the End of Rennie Street (Trench 4.5 m in length running North - South, north of TP-17.		
Description	**Depth Interval (m)**	**Sample Nº**
FILL, sandy silt and clay. Red/brown. Some dark staining and a few pieces of metal were present at 1.22 m on the side of the trench closest to Test Pit 17. A very slight refuse odour was also present in the same location.	0 - 1.98	T.P. 37B - 5' ft. (28 ppm)*
SHALE.(Weathered) Red/brown	1.21 (South end) - 1.98 (North end)	
End of Test Pit	1.3 (South end) - 1.98 (North end)	

Log № TP38	Date: June 26, 2000	Inspector: M. Graham
Location: Northeast corner of site, half way up the hill.		
Description	**Depth Interval (m)**	**Sample №**
SANDY SILT. Brown with gravel	0 - 0.61	
FILL, sandy silt. Dark brown with slight refuse odour, and street sweeping debris including plastic and metal.	0.61 - 2.43	T.P. 38 - 2-4' ft. (90 ppm)* T.P. 38 - 8' ft. (30 ppm)*
End of Test Pit	2.43	

Note: "*" – Total hydrocarbon vapours measured using Gastech Trace-Tector.

APPENDIX B

Water Levels and Hydraulic Conductivity Testing Data

Table B-1
WATER LEVELS
RENNIE STREET LANDFILL

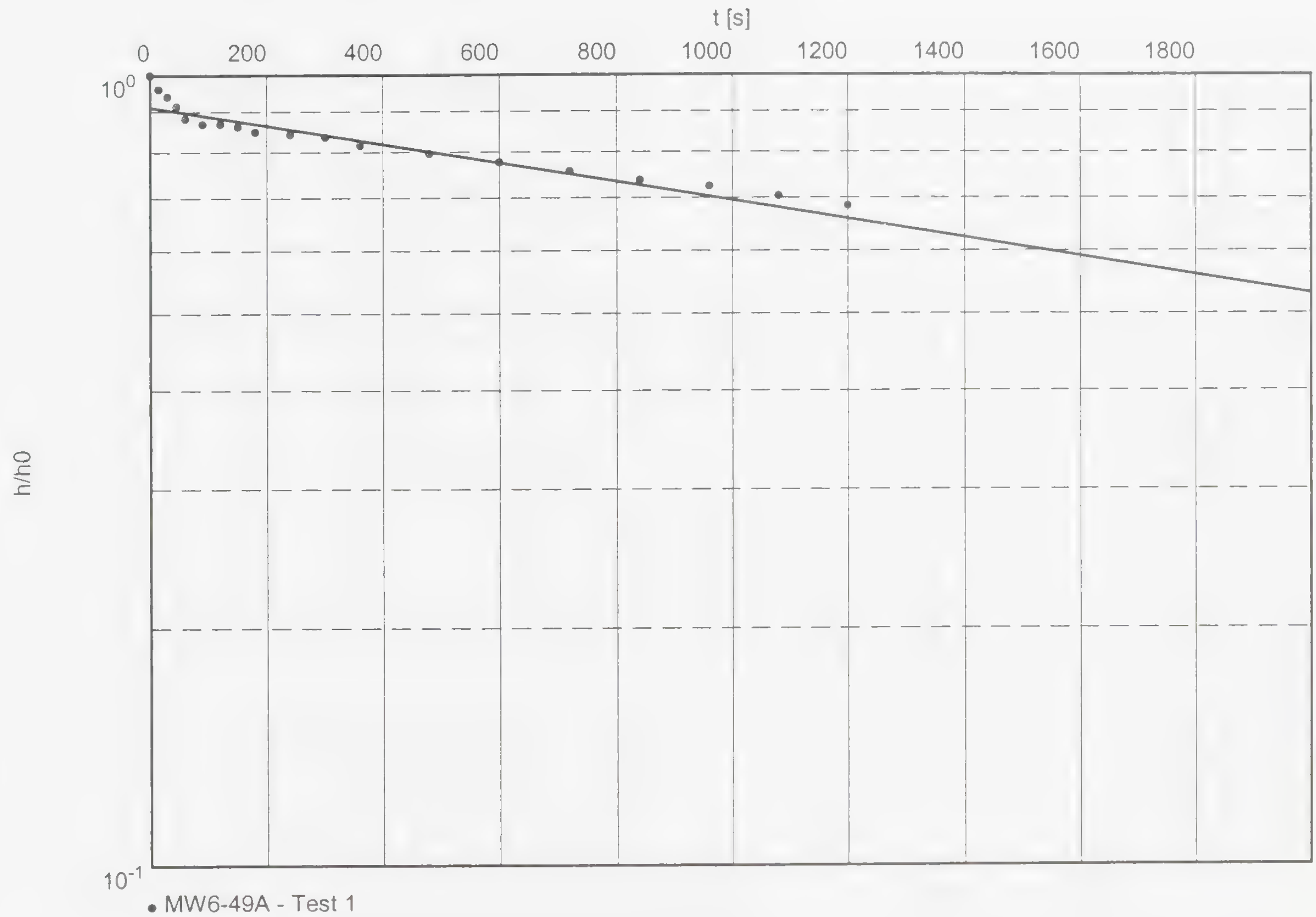
Well I.D.	Top of Pipe Elevation (m.a.s.l.)	Sept 25 1997 Water Level (m.b.t.p.)	(m.a.s.l.)	Oct 1 1997 Water Level (m.b.t.p.)	(m.a.s.l.)	Oct 21 1997 Water Level (m.b.t.p.)	(m.a.s.l.)	May 5 1998 Water Level (m.b.t.p.)	(m.a.s.l.)	Sept 30 1998 Water Level (m.b.t.p.)	(m.a.s.l.)	Oct 9, 1998 Water Level (m.b.t.p.)	(m.a.s.l.)	Aug 27 1999 Water Level (m.b.t.p.)	(m.a.s.l.)	May 12 2000 Water Level (m.b.t.p.)	(m.a.s.l.)	May 15 2000 Water Level (m.b.t.p.)	(m.a.s.l.)	May 15 2000 Product Thickness(m)	May 17 2000 Water Level (m.b.t.p.)	(m.a.s.l.)	May 18 2000 Water Level (m.b.t.p.)	(m.a.s.l.)	May 19 2000 Water Level (m.b.t.p.)	(m.a.s.l.)	July 19, 2000 Water Level (m.b.t.p.)	(m.a.s.l.)	July 19, 2000 Product Thickness(m)
Groundwater Monitoring Wells																													
6-11	85.38	5.95	79.43					6.20	79.19					5.80	79.78			6.34	79.04	0							5.25	79.13	N.M.
6-12	85.16	7.87	77.29					5.10	80.06					5.58	79.58			5.17	79.99	0.003							4.5[illegible]	80.66	[illegible]
6-13	83.83	6.04	77.79					5.94	77.89					6.21	77.62			6.35	77.48	0							5.91	77.92	N.M.
6-14a	85.62							6.13	79.49					6.48	79.15			6.42	79.20	0							6.22	79.40	N.M.
6-15	85.76							6.55	79.21					6.89	78.87			6.77	79.00	0							6.54	79.22	N.M.
6-21	[illegible]							7.28	78.44					7.50	78.27			7.45	78.32	0							7.62	78.15	N.M.
6-22	85.49							5.88	79.61					-						0							Destroyed		N.M.
6-23	85.65							6.43	79.22					6.78	78.87			6.65	79.01	0							6.58	79.07	N.M.
6-24	85.64							6.65	78.99					-						N.M.							Destroyed		N.M.
6-25	85.57							6.15	79.42					6.48	79.10			6.35	79.22	N.M.							6.13	79.44	N.M.
6-42	85.02											6.54	78.48	6.46	78.56			6.42	78.60	0							6.11	78.91	N.M.
6-43	84.72											8.35	78.37	6.24	78.48			5.81	78.92	0.002							5.46	79.26	[illegible]
6-44	87.08											11.32	75.76	11.52	75.56			11.17	75.91	0							10.97	75.11	slight sheen
6-47	85.63																	7.08	78.55	0.04 *1							6.96	78.67	[illegible]
6-48	87.84																	9.33	78.51	0							9.24	78.50	N.M.
6-49A	85.16																	2.665	82.495	0							2.94	82.22	N.M.
6-49B	85.10																	6.91	78.19	0							6.89	78.21	N.M.
6-50	83.72																	2.57	81.15	0							2.78	80.94	N.M.
6-51A	76.97															2.09	74.88	1.58	75.39	0	2.34	74.63	2.61	74.36	2.78	74.19	1.49	75.48	0
6-51B	77.08															1.67	75.41	1.77	75.31	0	1.76	75.32	[illegible]	75.37	1.72	75.36	1.64	75.44	0
6-52A	76.29															3.08	73.21	0.35	75.94	0	2.47	73.82	2.2[illegible]	74.02	0.99	75.30	0.54	75.75	0
6-52B	76.25															0.75	75.5	0.76	75.49	0	0.77	75.48	0.75	75.5	0.75	75.50	0.69	75.56	0
6-53A	76.80															2.83	73.97	1.52	75.28	0	1.69	75.11	2.1[illegible]	74.63	2.16	74.64	1.33	75.47	0
6-53B	76.84															1.55	75.29	1.54	75.3	0	1.54	75.30	1.46	75.38	1.48	75.36	1.51	75.33	0
6-57	84.59																	2.67	81.92								3.29	81.30	N.M.
6-58A	84.39																										2.28	82.11	0
6-58B	84.26																										3.53	80.73	0
6-59	82.88																										1.07	81.81	0
6-60	83.97																										4.35	79.62	0
6-61	82.57																										0.81	81.76	0
6-63	83.17																										Dry		Dry
6-64	83.51																										Dry		Dry
6-65	83.79																										Dry		Dry
PW6-1	85.12																			Possibly 0.03							6.69	78.43	Present *3
GW-1	84.77																	Dry		0							Dry		Slight Sheen
GW-2	84.28																	1.14	83.14	0							1.62	82.66	0
GW-3	84.10																	0.54	83.56	0							1.42	82.68	0
GW-4	83.38																	0.1	83.28	0							0.18	83.20	0
GW-5	83.89																	1.665	82.225	0							2.41	81.48	0
GW-6	83.76																	2.32	81.44	0							2.64	81.12	0
GW-7	82.29																	2.8	79.488	0							3.36	78.33	N.M.
W101	84.30																	6.34	77.96	Present *3							6.05	78.25	Present *3
PM BH1A	86.77																	7.67	79.1	Present *3							6.78	79.99	N.M.
PM BH2A	84.29																	3.53	80.76	Present *3							6.1	78.19	Present *3
PM BH2B	84.30																	9.615	74.685	0							9.45	74.85	
PM BH3A	[illegible]																	5.56	81.02	0							5.56	81.32	
PM BH3B	86.22																	11.21	75.01	0							11.06	75.16	
PM BH4A	88.62																	8.13	80.492	0							7.78	80.84	
PM BH4B	88.77																	13.52	75.249	0							13.49	75.28	
Creek levels *2																													
[illegible]	[illegible]																						1.305	75.252	0.2	75.357	0.1 *4	75.46	
[illegible]	[illegible]																						1.355	75.259	0.21	75.404	0.24 *4	75.40	
[illegible]	[illegible]																						0.08	75.34	0.04	75.38	Destroyed ?		

NOTES

m.b.t.p.	meters below top of pipe
m.a.s.l.	meter above sea level
N.M.	not measured
*1	Subsequent measurements indicate product thickness is increasing at this location (0.10 m on May 23)
*2	meters below top of T-bar (for creek levels only)
*3	Free - Product present on the water table at this location but the interface probe did not respond to the material
*4	T-Bars which are used to measure creek levels were bent over on a 15-20 degree angle

Dillon Consulting Ltd. 1425 Bishop Street Cambridge,Ontario	slug/bail test analysis BOUWER-RICE's method	1, Page 1
		Project: Rennie Street Landfill
		Evaluated by: IJH / Date: 16.05.2000

Slug Test No. 1	Test conducted on: May 12, 2000
MW6-49A	



Hydraulic conductivity [m/s]: 7.03×10^{-8}

Dillon Consulting Ltd. 1425 Bishop Street Cambridge,Ontario	slug/bail test analysis BOUWER-RICE's method	1, Page 2	
		Project: Rennie Street Landfill	
		Evaluated by: IJH	Date: 16.05.2000

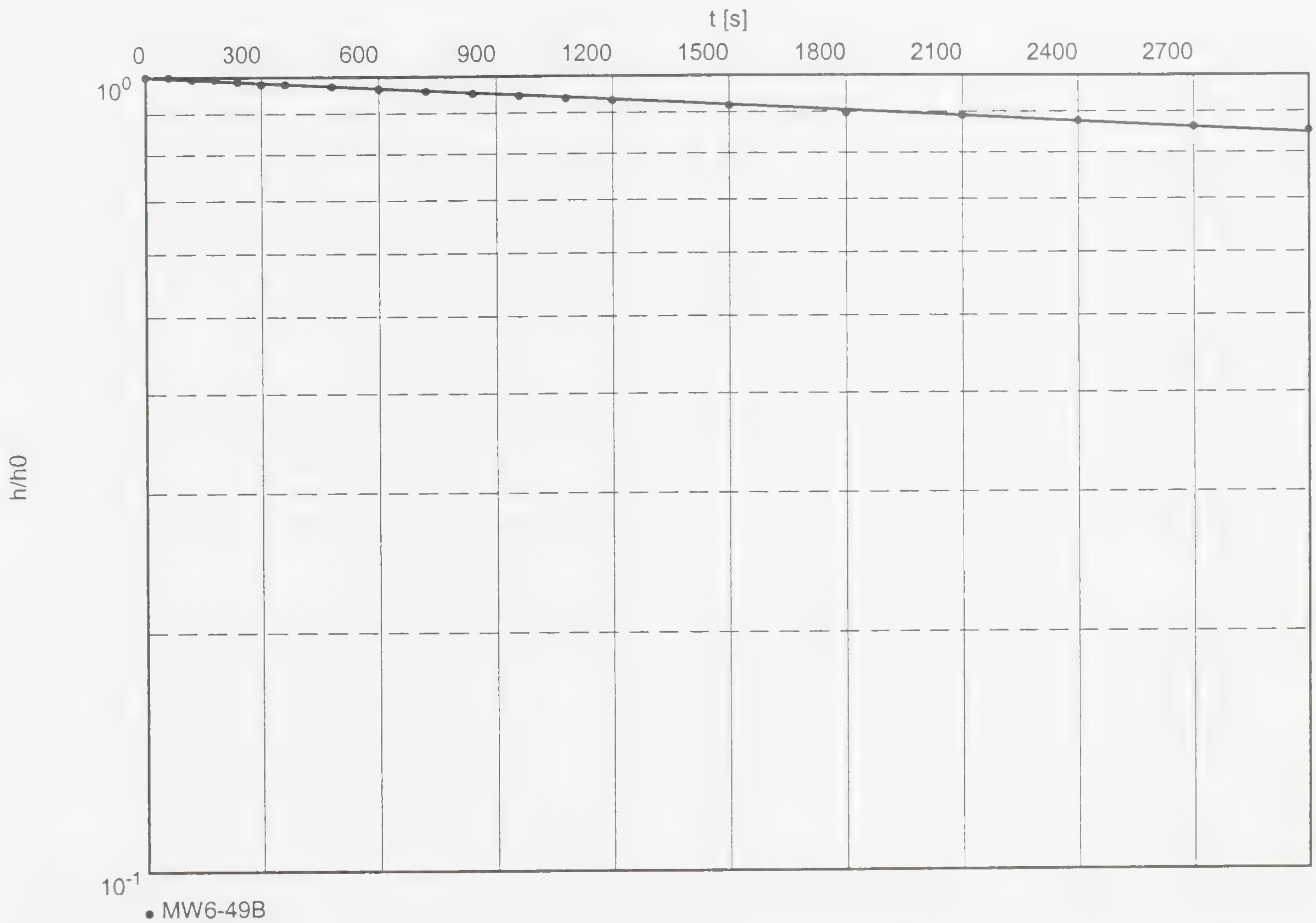
Slug Test No. 1	Test conducted on: May 12, 2000
MW6-49A	MW6-49A - Test 1

Static water level: 2.940 m below datum

	Pumping test duration [s]	Water level [m]	Drawdown [m]	
1	0	1.420	-1.520	
2	15	1.480	-1.460	
3	30	1.510	-1.430	
4	45	1.550	-1.390	
5	60	1.600	-1.340	
6	90	1.620	-1.320	
7	120	1.620	-1.320	
8	150	1.630	-1.310	
9	180	1.650	-1.290	
10	240	1.660	-1.280	
11	300	1.670	-1.270	
12	360	1.700	-1.240	
13	480	1.730	-1.210	
14	600	1.760	-1.180	
15	720	1.790	-1.150	
16	840	1.820	-1.120	
17	960	1.840	-1.100	
18	1080	1.870	-1.070	
19	1200	1.900	-1.040	

Dillon Consulting Ltd. 1425 Bishop Street Cambridge,Ontario	slug/bail test analysis HVORSLEV's method	1, Page 1 Project: Rennie Street Landfill Evaluated by: IJH — Date: 17.05.2000

Slug Test No. 1	Test conducted on: May 17, 2000
MW6-49B (Deep)	



Hydraulic conductivity [m/s]: 2.40×10^{-8}

Dillon Consulting Ltd. 1425 Bishop Street Cambridge,Ontario	slug/bail test analysis HVORSLEV's method	1, Page 2 Project: Rennie Street Landfill Evaluated by: IJH / Date: 17.05.2000

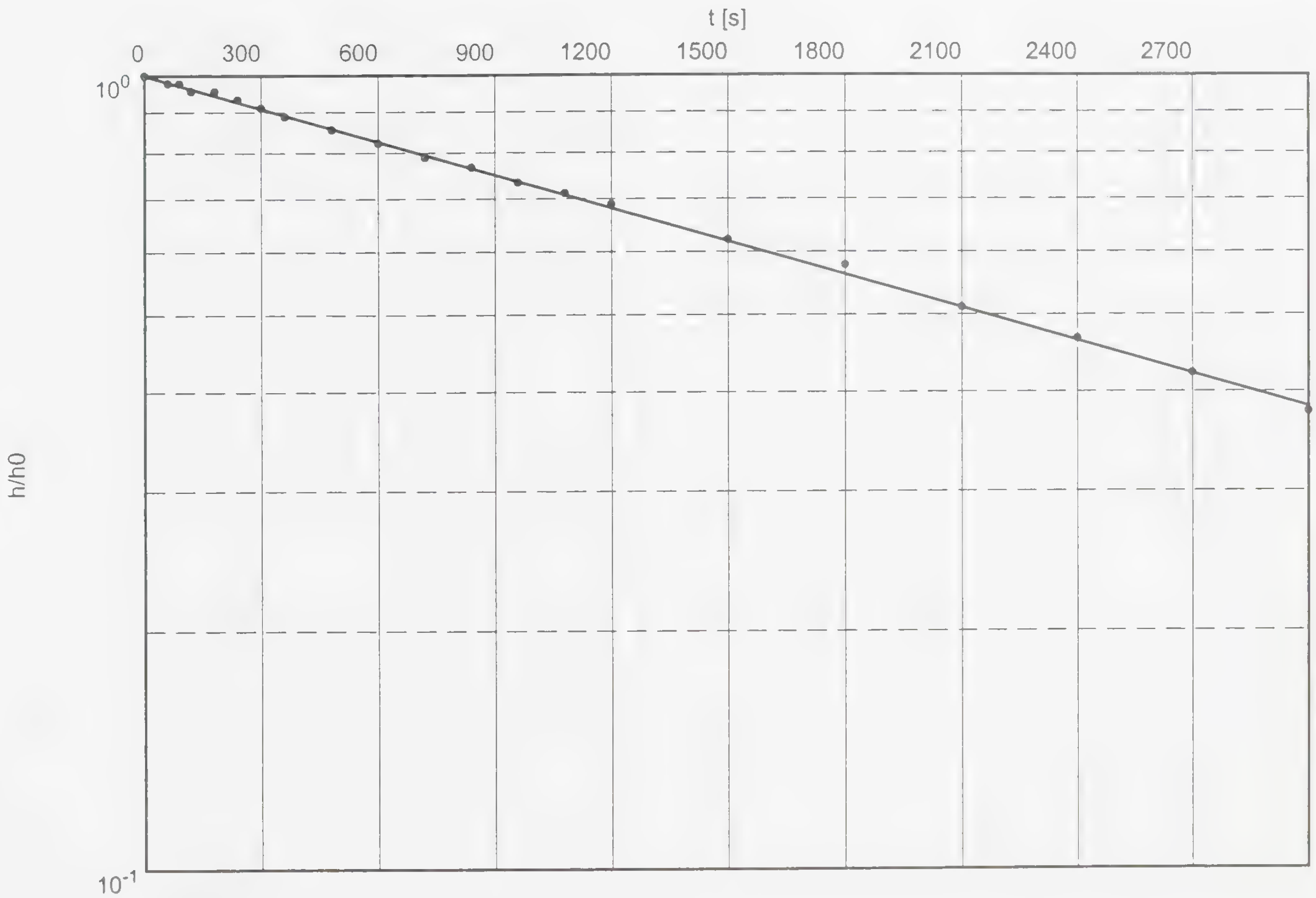
Slug Test No. 1	Test conducted on: May 17, 2000
MW6-49B (Deep)	MW6-49B

Static water level: 6.900 m below datum

	Pumping test duration [s]	Water level [m]	Change in Waterlevel [m]	
1	0	5.450	-1.450	
2	60	5.450	-1.450	
3	120	5.460	-1.440	
4	180	5.460	-1.440	
5	240	5.470	-1.430	
6	300	5.480	-1.420	
7	360	5.480	-1.420	
8	480	5.490	-1.410	
9	600	5.500	-1.400	
10	720	5.510	-1.390	
11	840	5.520	-1.380	
12	960	5.530	-1.370	
13	1080	5.540	-1.360	
14	1200	5.550	-1.350	
15	1500	5.570	-1.330	
16	1800	5.600	-1.300	
17	2100	5.610	-1.290	
18	2400	5.630	-1.270	
19	2700	5.650	-1.250	
20	3000	5.665	-1.235	

Dillon Consulting Ltd. 1425 Bishop Street Cambridge,Ontario	slug/bail test analysis BOUWER-RICE's method	1, Page 1 Project: Rennie Street Landfill Evaluated by: IJH — Date: 17.05.2000

Slug Test No. 1	Test conducted on: May 17, 2000
MW6-50	



• MW6-50

Hydraulic conductivity [m/s]: 1.26×10^{-7}

Dillon Consulting Ltd. 1425 Bishop Street Cambndge,Ontario	slug/bail test analysis BOUWER-RICE's method	1, Page 2 Project: Rennie Street Landfill Evaluated by: IJH — Date: 17.05.2000

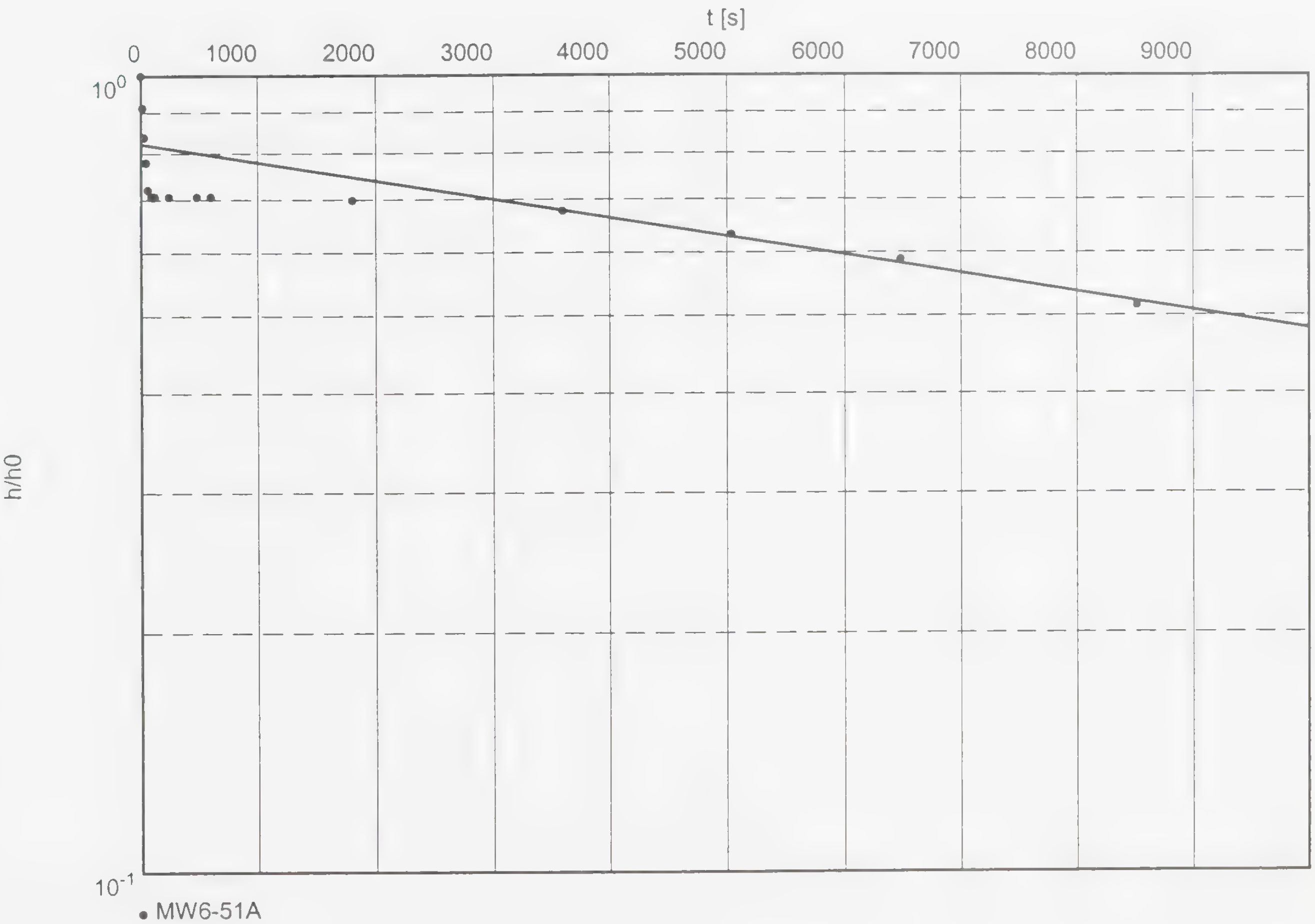
Slug Test No. 1	Test conducted on: May 17, 2000
MW6-50	MW6-50

Static water level: 2.500 m below datum

	Pumping test duration [s]	Water level [m]	Drawdown [m]	
1	0	2.050	-0.450	
2	60	2.060	-0.440	
3	90	2.060	-0.440	
4	120	2.070	-0.430	
5	180	2.070	-0.430	
6	240	2.080	-0.420	
7	300	2.090	-0.410	
8	360	2.100	-0.400	
9	480	2.115	-0.385	
10	600	2.130	-0.370	
11	720	2.145	-0.355	
12	840	2.155	-0.345	
13	960	2.170	-0.330	
14	1080	2.180	-0.320	
15	1200	2.190	-0.310	
16	1500	2.220	-0.280	
17	1800	2.240	-0.260	
18	2100	2.270	-0.230	
19	2400	2.290	-0.210	
20	2700	2.310	-0.190	
21	3000	2.330	-0.170	

Dillon Consulting Ltd. 1425 Bishop Street Cambridge,Ontario	slug/bail test analysis BOUWER-RICE's method	1, Page 1
		Project: Rennie Street Landfill
		Evaluated by IJH | Date: 24.05.2000

Slug Test No. 1	Test conducted on: 23.05.00
MW6-51A	



Hydraulic conductivity [m/s]: 6.65×10^{-9}

Dillon Consulting Ltd. 1425 Bishop Street Cambridge,Ontario	slug/bail test analysis BOUWER-RICE's method	1, Page 2 Project: Rennie Street Landfill Evaluated by: IJH — Date: 24.05.2000

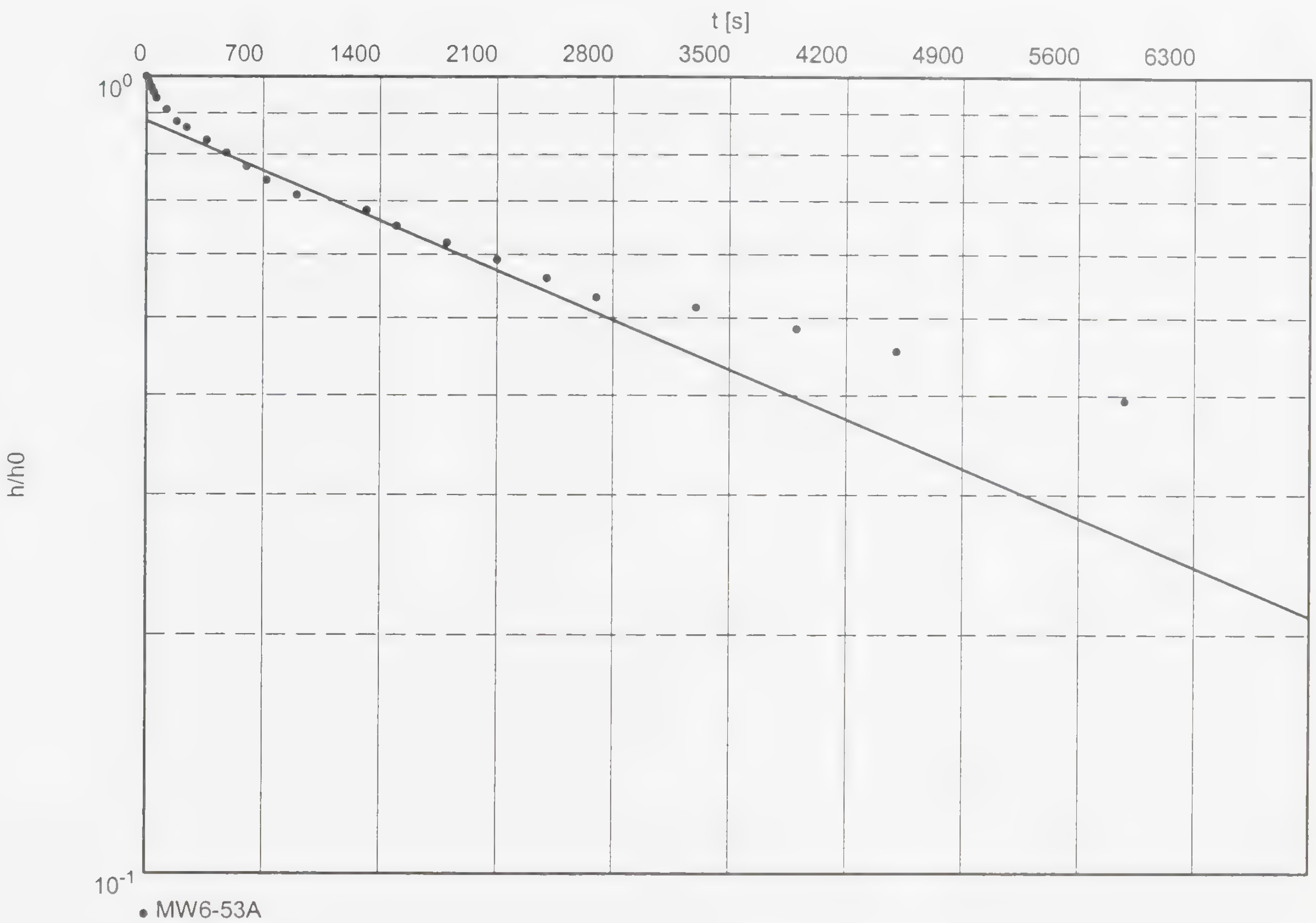
Slug Test No. 1	Test conducted on: 23.05.00
MW6-51A	MW6-51A

Static water level: 1.640 m below datum

	Pumping test duration [s]	Water level [m]	Drawdown [m]	
1	0	0.960	-0.680	
2	15	1.020	-0.620	
3	30	1.070	-0.570	
4	45	1.110	-0.530	
5	60	1.150	-0.490	
6	90	1.160	-0.480	
7	120	1.160	-0.480	
8	240	1.160	-0.480	
9	480	1.160	-0.480	
10	600	1.160	-0.480	
11	1800	1.165	-0.475	
12	3600	1.180	-0.460	
13	5040	1.210	-0.430	
14	6480	1.240	-0.400	
15	8520	1.290	-0.350	
16	10380	1.320	-0.320	

Dillon Consulting Ltd. 1425 Bishop Street Cambridge,Ontario	slug/bail test analysis BOUWER-RICE's method	1, Page 1 Project: Rennie Street Landfill Evaluated by: IJH / Date: 24.05.2000

Slug Test No. 1	Test conducted on: 23.05.00
MW6-53A	



Hydraulic conductivity [m/s]: 4.37×10^{-8}

Dillon Consulting Ltd. 1425 Bishop Street Cambndge,Ontano	slug/bail test analysis BOUWER-RICE's method	1, Page 2 Project: Rennie Street Landfill Evaluated by: IJH · Date: 24.05.2000

Slug Test No. 1	Test conducted on: 23.05.00
MW6-53A	MW6-53A

Static water level: 1.420 m below datum

	Pumping test duration [s]	Water level [m]	Drawdown [m]	
1	0	0.760	-0.660	
2	15	0.770	-0.650	
3	30	0.780	-0.640	
4	45	0.790	-0.630	
5	60	0.800	-0.620	
6	120	0.820	-0.600	
7	180	0.840	-0.580	
8	240	0.850	-0.570	
9	360	0.870	-0.550	
10	480	0.890	-0.530	
11	600	0.910	-0.510	
12	720	0.930	-0.490	
13	900	0.950	-0.470	
14	1320	0.970	-0.450	
15	1500	0.990	-0.430	
16	1800	1.010	-0.410	
17	2100	1.030	-0.390	
18	2400	1.050	-0.370	
19	2700	1.070	-0.350	
20	3300	1.080	-0.340	
21	3900	1.100	-0.320	
22	4500	1.120	-0.300	
23	5880	1.160	-0.260	

PROJECT NAME: Red Hill Creek - Renie Street Landfill

MONITORING WELL: MW6-12
STATIC WATER LEVEL: 5.59 (m)
DRAWDOWN AT t=0 (Ho): 4.57 (m)

DATE: October 13, 1998
CONDUCTED BY: AD
MEASURING POINT: Top of pipe

ELAPSED TIME (min)	DEPTH TO WATER (m)	DRAWDOWN (h) (m)	h/Ho
1	4.96	0.63	0.618
1.5	4.99	0.60	0.588
2	5.02	0.57	0.559
2.5	5.04	0.55	0.539
3	5.06	0.53	0.520
3.5	5.09	0.50	0.490
4	5.11	0.48	0.471
5	5.14	0.45	0.441
5.5	5.16	0.43	0.422
6	5.18	0.41	0.402
7	5.21	0.38	0.373
8	5.24	0.35	0.343
9	5.28	0.31	0.304
10	5.30	0.29	0.284
31	5.54	0.05	0.049

PERMEABILITY CALCULATIONS
(After Hvorslev, 1951)

Installation Radius (r): 0.025 m

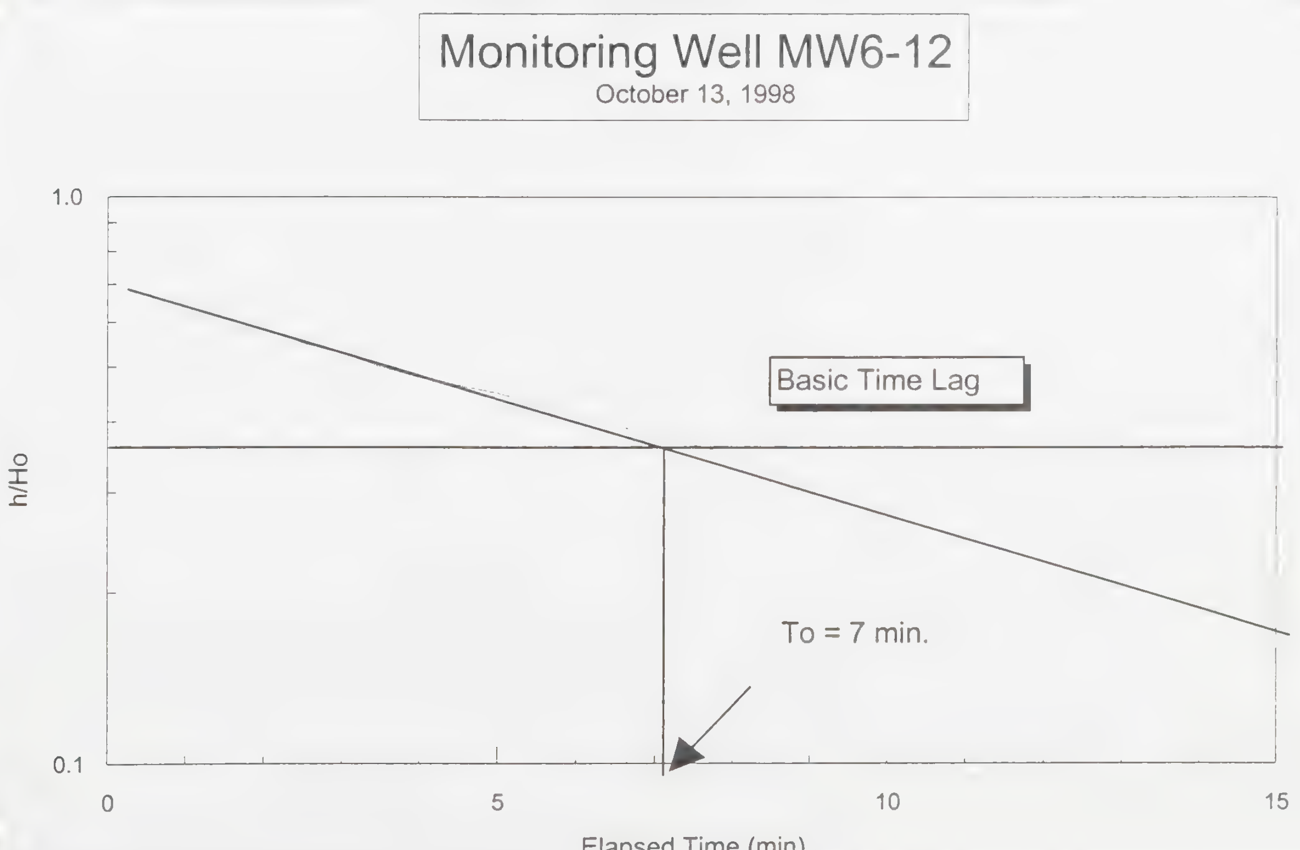
Length of Sand Pack (L): 1.52 m

Diameter of Pack (D): 0.2 m

Basic Time Lag (To): 7 min

Estimate of Permeability
k={r X r X ln (2 X L/D)}/(2 X L X T)

Therefore k= 1.3E-004 cm/s



PROJECT NAME:	Red Hill Creek - Renie Street Landfill		
MONITORING WELL:	MW6-13	DATE:	October 13, 1998
STATIC WATER LEVEL:	6.07 (m)	CONDUCTED BY:	AD
DRAWDOWN AT t=0 (Ho):	4.03 (m)	MEASURING POINT:	Top of pipe

ELAPSED TIME (min)	DEPTH TO WATER (m)	DRAWDOWN (h) (m)	h/Ho
1	5.99	0.08	0.039
2	6.01	0.06	0.029
2.5	6.02	0.05	0.025
3.5	6.03	0.04	0.020
4.5	6.04	0.03	0.015
7	6.05	0.02	0.010

PERMEABILITY CALCULATIONS
(After Hvorslev, 1951)

Installation Radius (r): 0.025 m

Length of Sand Pack (L): 1.52 m

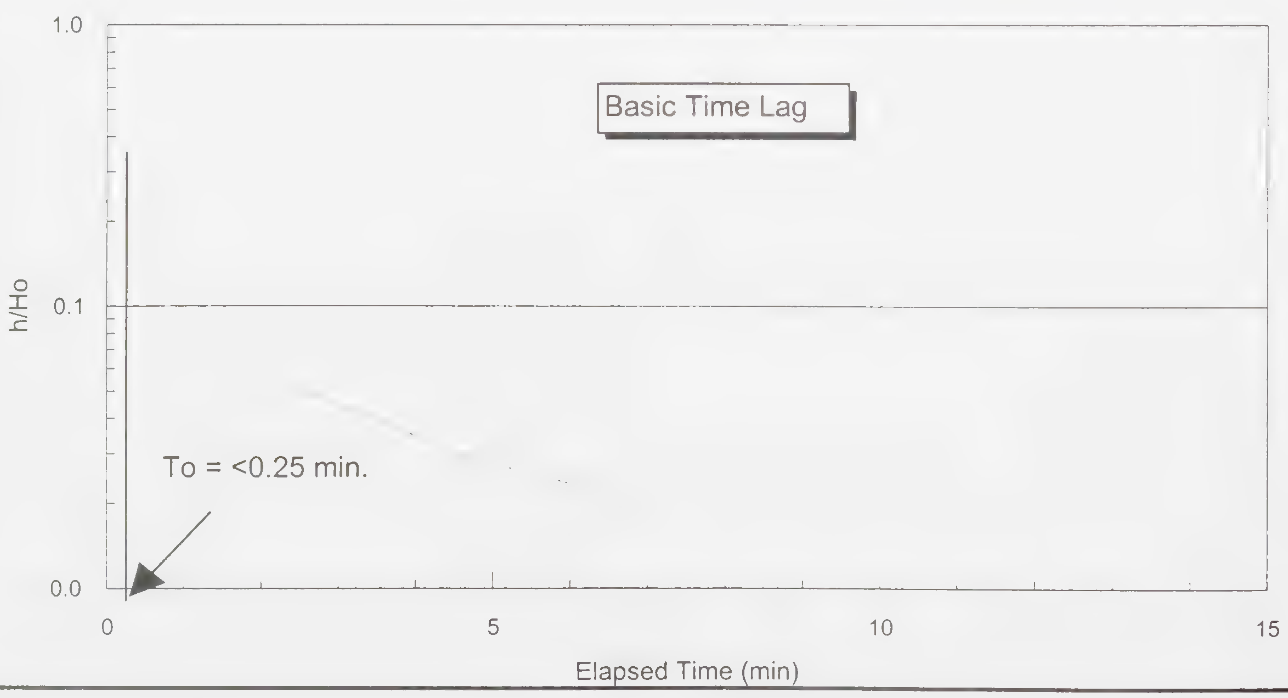
Diameter of Pack (D): 0.2 m

Basic Time Lag (To): < 0.25 min

Estimate of Permeability
k={r X r X ln (2 X L/D)}/(2 X L X T)

Therefore k> 3.7E-003 cm/s

Monitoring Well MW6-44
October 13, 1998



PROJECT NAME:	Red Hill Creek - Renie Street Landfill				
MONITORING WELL:	MW6-43		DATE:	October 13, 1998
STATIC WATER LEVEL:	6.29	(m)	CONDUCTED BY:	AD
DRAWDOWN AT t=0 (Ho):	5.27	(m)	MEASURING POINT:	Top of pipe

ELAPSED TIME (min)	DEPTH TO WATER (m)	DRAWDOWN (h) (m)	h/Ho
1.5	6.27	0.02	0.020
2	6.28	0.01	0.010
4.5	6.29	0.00	0.000

PERMEABILITY CALCULATIONS
(After Hvorslev, 1951)

Installation Radius (r): 0.025 m

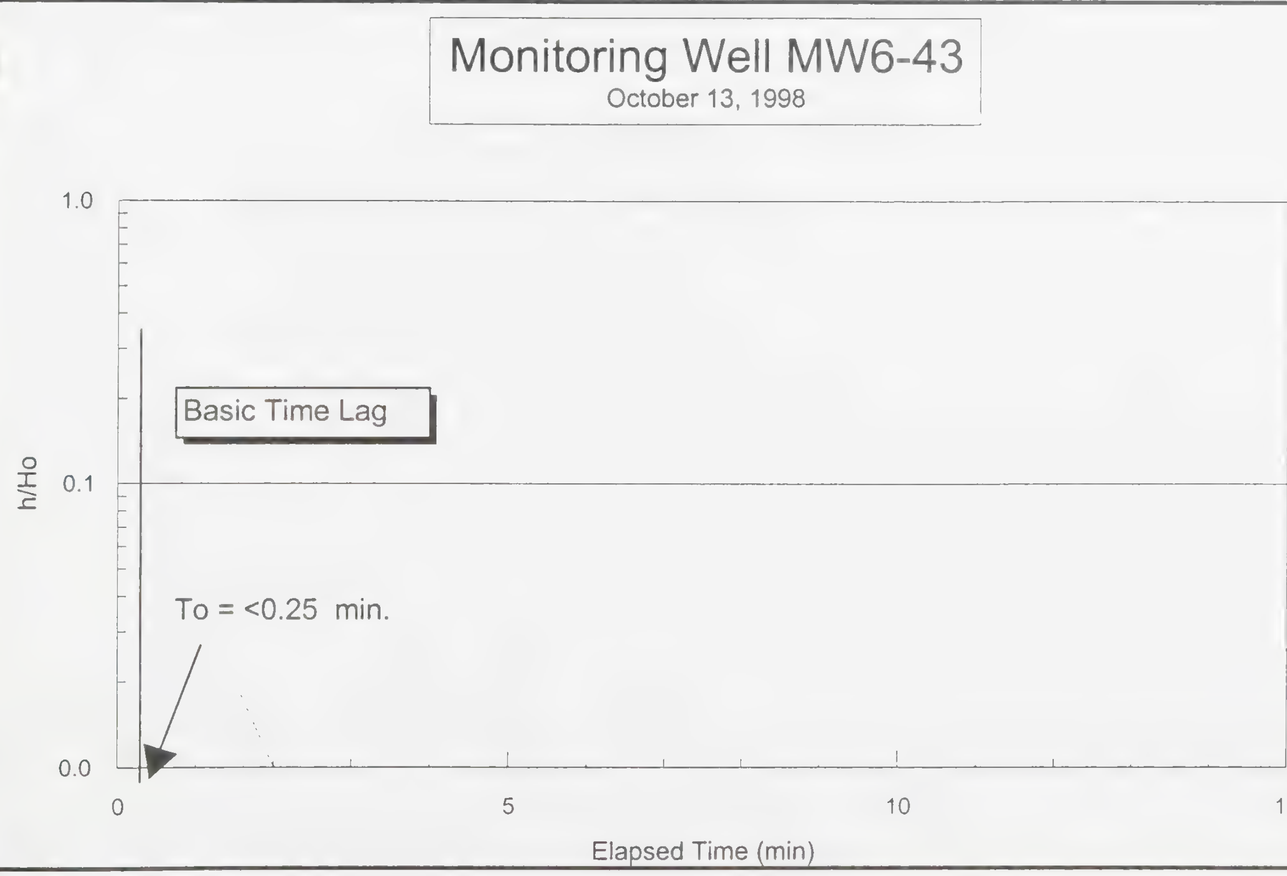
Length of Sand Pack (L): 1.52 m

Diameter of Pack (D): 0.2 m

Basic Time Lag (To): < 0.25 min

Estimate of Permeability
k={r X r X ln (2 X L/D)}/(2 X L X T)

Therefore k> 3.7E-003 cm/s



PROJECT NAME:	Rennie Street Landfill				
MONITORING WELL:	MW6-44		DATE:	October 13, 1998	
STATIC WATER LEVEL:	11.60	(m)	CONDUCTED BY:	AD	
DRAWDOWN AT t=0 (Ho):	9.56	(m)	MEASURING POINT:	Top of pipe	

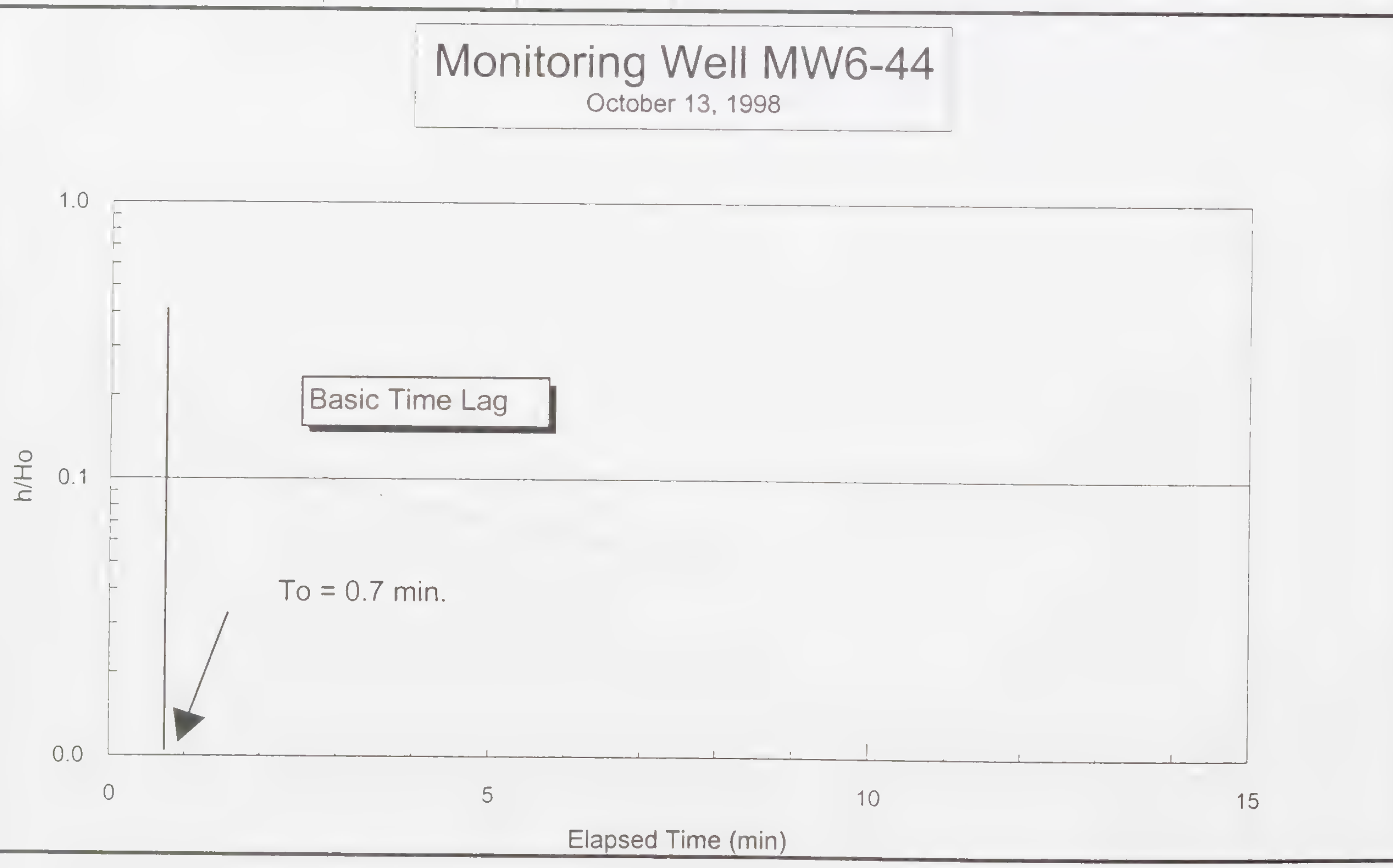
ELAPSED TIME (min)	DEPTH TO WATER (m)	DRAWDOWN (h) (m)	h/Ho
1.5	11.45	0.15	0.074
2	11.48	0.12	0.059
4	11.52	0.08	0.039
5	11.53	0.07	0.034
8	11.55	0.05	0.025

PERMEABILITY CALCULATIONS
(After Hvorslev, 1951)

Installation Radius (r):	0.025	m
Length of Sand Pack (L):	1.52	m
Diameter of Pack (D):	0.2	m
Basic Time Lag (To):	0.70	min

Estimate of Permeability
k={r X r X ln (2 X L/D)}/(2 X L X T)

Therefore k> 1.3E-003 cm/s



PROJECT NAME: Rennie Street

MONITORING WELL:	MW6-58A		DATE:	August 1, 2000
STATIC WATER LEVEL:	2.47	(m)	CONDUCTED BY:	MG
DRAWDOWN AT t=0 (Ho):	0.07	(m)	MEASURING POINT:	Top of pipe

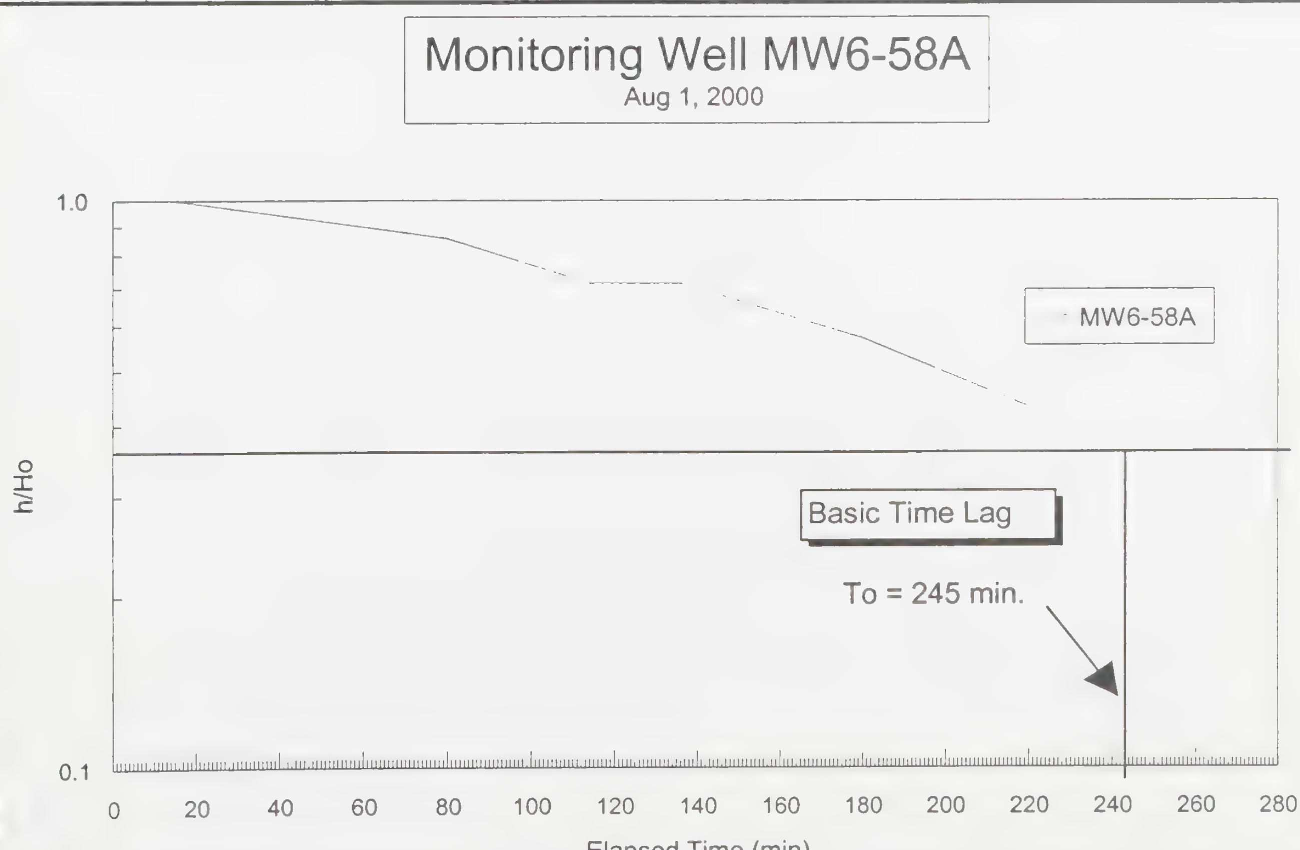
ELAPSED TIME (min)	DEPTH TO WATER (m)	DRAWDOWN (h) (m)	h/Ho
0.25	2.4	0.07	1.000
0.5	2.4	0.07	1.000
0.75	2.4	0.07	1.000
1	2.4	0.07	1.000
2	2.4	0.07	1.000
8	2.4	0.07	1.000
15	2.4	0.07	1.000
80	2.41	0.06	0.857
114	2.42	0.05	0.714
136	2.42	0.05	0.714
180	2.43	0.04	0.571
221	2.44	0.03	0.429

PERMEABILITY CALCULATIONS
(After Hvorslev, 1951)

Installation Radius (r):	0.025 m
Length of Sand Pack (L):	2.23 m
Diameter of Pack (D):	0.12 m
Basic Time Lag (To):	245 min

Estimate of Permeability
k={r X r X ln (2 X L/D)}/(2 X L X T)

Therefore k= 3.4E-006 cm/s



PROJECT NAME:	Rennie Street				
MONITORING WELL:	MW6-58B Test 1		DATE:	August 1, 2000
STATIC WATER LEVEL:	3.68	(m)	CONDUCTED BY:	MG
DRAWDOWN AT t=0 (Ho):	0.83	(m)	MEASURING POINT:	Top of pipe

ELAPSED TIME (min)	DEPTH TO WATER (m)	DRAWDOWN (h) (m)	h/Ho
0.25	2.85	0.83	1.000
0.5	2.92	0.76	0.916
0.75	3.06	0.62	0.747
1.5	3.33	0.35	0.422
2	3.42	0.26	0.313
2.5	3.47	0.21	0.253
3	3.52	0.16	0.193
4	3.56	0.12	0.145
5	3.59	0.09	0.108
6	3.60	0.08	0.096
8	3.61	0.07	0.084
10	3.63	0.05	0.060
12	3.64	0.04	0.048
15	3.64	0.04	0.048
20	3.65	0.03	0.036
25	3.65	0.03	0.036

PERMEABILITY CALCULATIONS
(After Hvorslev, 1951)

Installation Radius (r): 0.012 m

Length of Sand Pack (L): 3.05 m

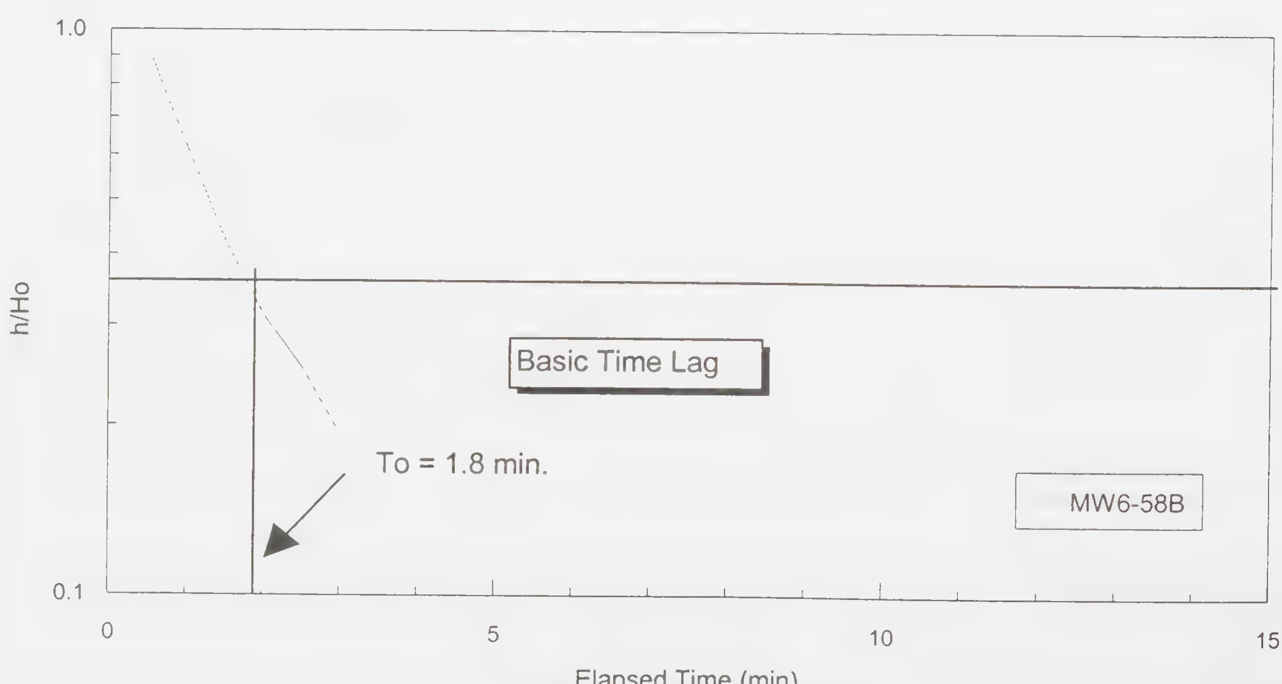
Diameter of Pack (D): 0.088 m

Basic Time Lag (To): 1.8 min

Estimate of Permeability
k={r X r X ln (2 X L/D)}/(2 X L X T)

Therefore k= 9.3E-005 cm/s

Monitoring Well MW6-58B
Aug 1, 2000 Test # 1



PROJECT NAME:	Rennie Street				
MONITORING WELL:	MW6-58B Test 2		DATE:	August 1, 2000
STATIC WATER LEVEL:	3.65	(m)	CONDUCTED BY:	MG
DRAWDOWN AT t=0 (Ho):	0.87	(m)	MEASURING POINT:	Top of pipe

ELAPSED TIME (min)	DEPTH TO WATER (m)	DRAWDOWN (h) (m)	h/Ho
0.25	2.78	0.87	1.000
0.5	2.90	0.75	0.862
0.75	3.09	0.56	0.644
1.5	3.33	0.32	0.368
2	3.40	0.25	0.287
3	3.48	0.17	0.195
4	3.53	0.12	0.138
5	3.56	0.09	0.109
6	3.56	0.09	0.103
8	3.59	0.06	0.069
10	3.60	0.05	0.057
12	3.61	0.04	0.046
15	3.61	0.04	0.046
20	3.62	0.03	0.034
25	3.62	0.03	0.034

PERMEABILITY CALCULATIONS
(After Hvorslev, 1951)

Installation
Radius (r): 0.012 m

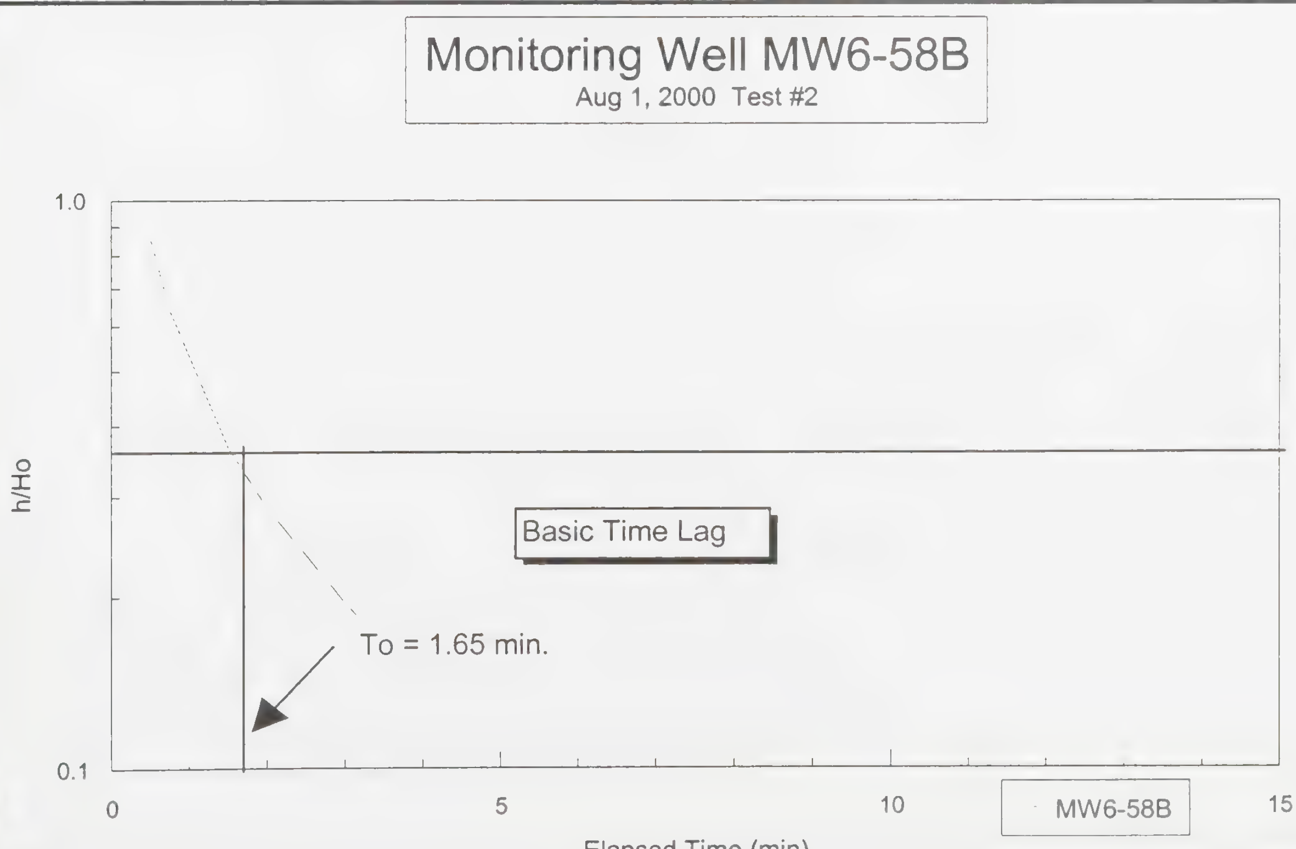
Length of Sand
Pack (L): 3.05 m

Diameter of Pack (D): 0.088 m

Basic Time Lag (To): 1.65 min

Estimate of Permeability
k={r X r X ln (2 X L/D)}/(2 X L X T)

Therefore k= 1.0E-004 cm/s



PROJECT NAME:	Rennie Street				
MONITORING WELL:	MW6-59		DATE:	August 1, 2000	
STATIC WATER LEVEL:	1.28	(m)	CONDUCTED BY:	MG	
DRAWDOWN AT t=0 (Ho):	0.035	(m)	MEASURING POINT:	Top of pipe	

ELAPSED TIME (min)	DEPTH TO WATER (m)	DRAWDOWN (h) (m)	h/Ho
0.25	1.245	0.03	1.000
0.5	1.25	0.03	0.857
0.75	1.25	0.03	0.857
1	1.25	0.03	0.857
2	1.252	0.03	0.800
4	1.253	0.03	0.771
8	1.255	0.03	0.714
16	1.26	0.02	0.571
25	1.26	0.02	0.571
35	1.265	0.02	0.429
45	1.267	0.01	0.371
55	1.272	0.01	0.229
76	1.28	0.00	0.000

PERMEABILITY CALCULATIONS
(After Hvorslev, 1951)

Installation Radius (r): 0.025 m

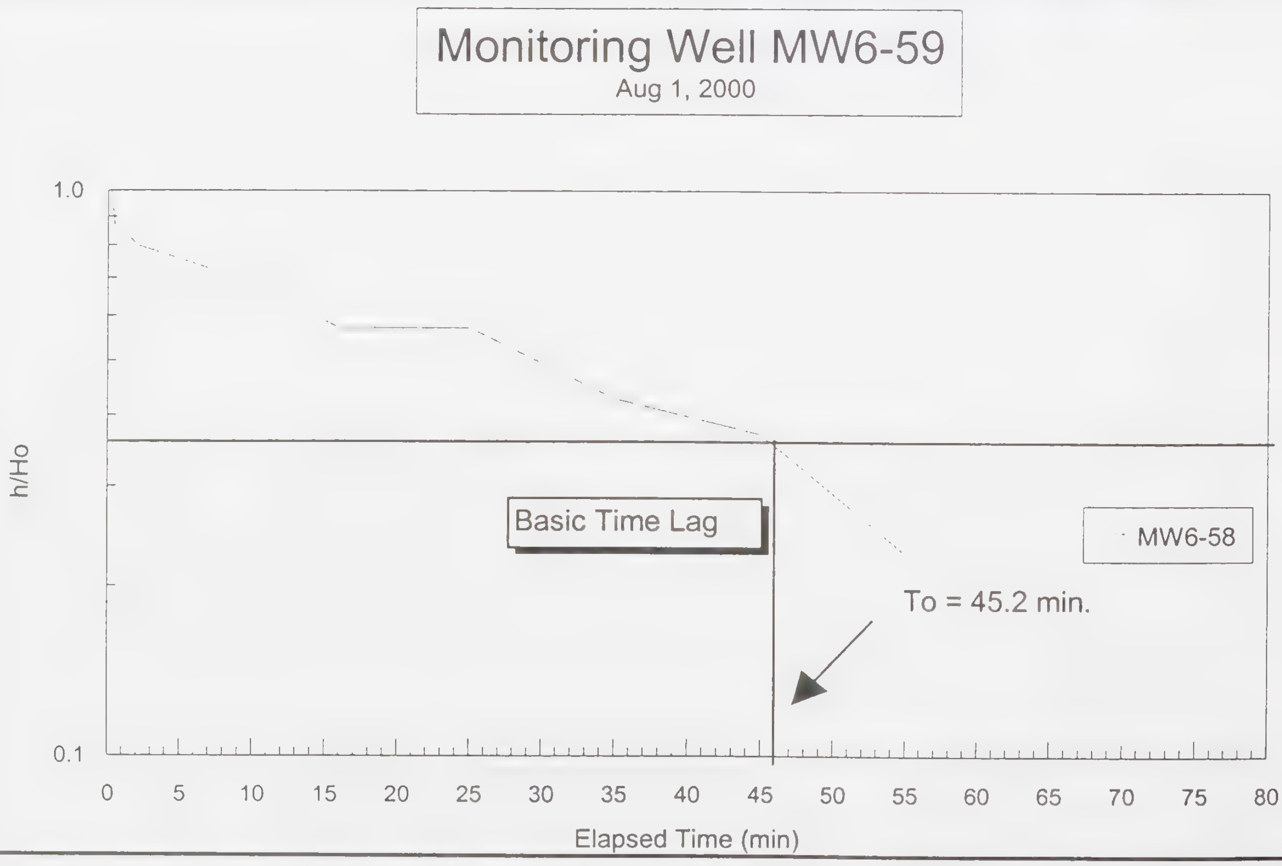
Length of Sand Pack (L): 3.05 m

Diameter of Pack (D): 0.12 m

Basic Time Lag (To): 45.2 min

Estimate of Permeability
k={r X r X ln (2 X L/D)}/(2 X L X T)

Therefore k= 1.5E-005 cm/s



Dillon Consulting Ltd. 1425 Bishop Street Cambridge,Ontario	slug/bail test analysis HVORSLEV's method	1, Page 2 Project: Rennie Street Landfill Evaluated by: IJH / Date: 21.05.2000

Slug Test No. 1	Test conducted on: May 18, 2000
MW6-53B	MW6-53B

Static water level: 1.570 m below datum

	Pumping test duration [s]	Water level [m]	Change in Waterlevel [m]	
1	0	0.600	-0.970	
2	15	0.680	-0.890	
3	30	0.750	-0.820	
4	45	0.790	-0.780	
5	60	0.820	-0.750	
6	90	0.890	-0.680	
7	120	0.930	-0.640	
8	150	0.970	-0.600	
9	180	1.000	-0.570	
10	240	1.060	-0.510	
11	300	1.100	-0.470	
12	360	1.140	-0.430	
13	480	1.190	-0.380	
14	600	1.230	-0.340	
15	720	1.270	-0.300	
16	840	1.300	-0.270	
17	960	1.310	-0.260	

Dillon Consulting Ltd. 1425 Bishop Street Cambndge,Ontario	slug/bail test analysis HVORSLEV's method	1, Page 2 Project: Rennie Street Landfill Evaluated by: IJH · Date: 17.05.2000

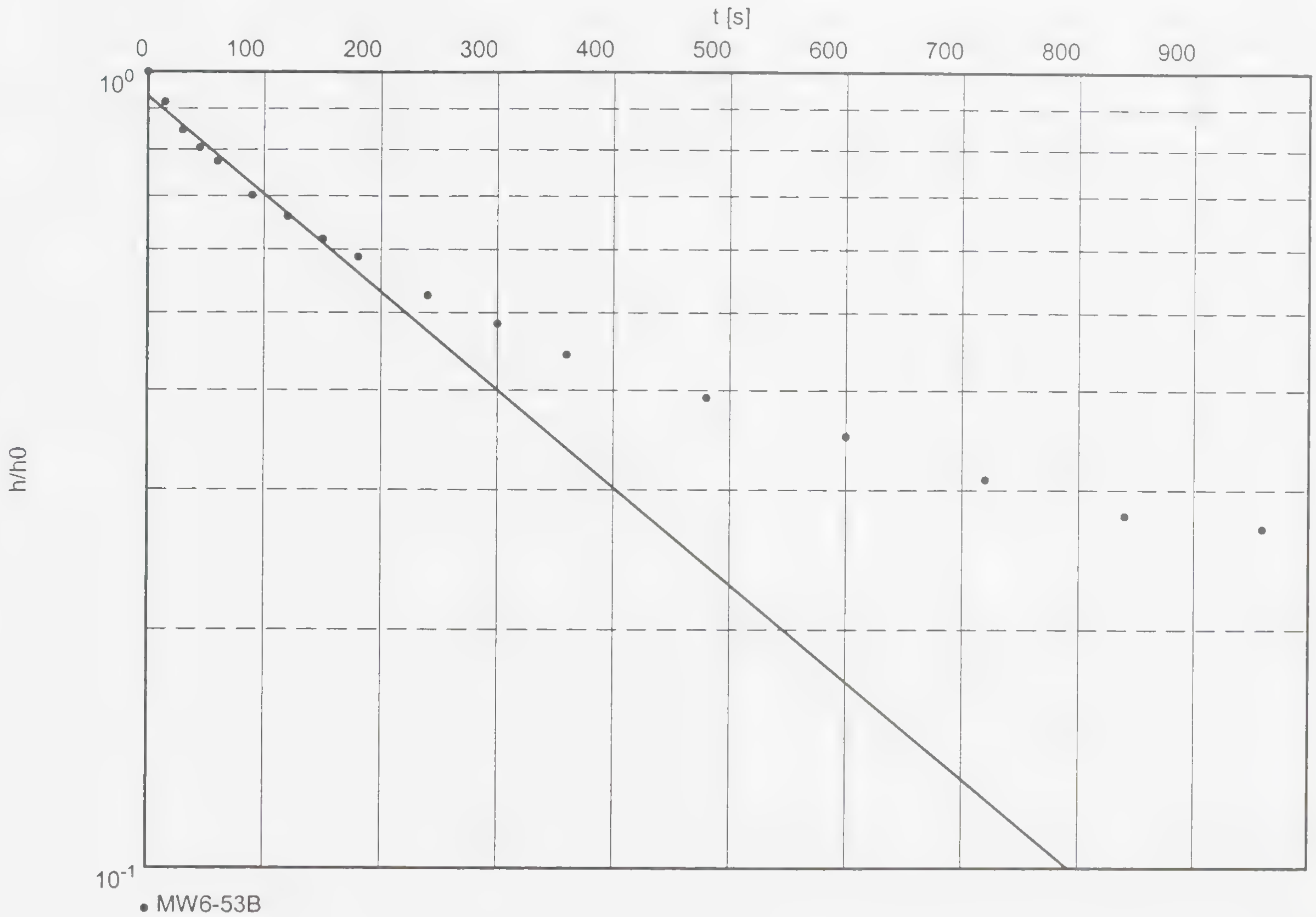
Slug Test No. 1	Test conducted on: May 13, 2000
MW52-B (deep)	MW6-52B

Static water level: 0.750 m below datum

	Pumping test duration [s]	Water level [m]	Change in Waterlevel [m]	
1	0	0.100	-0.650	
2	15	0.250	-0.500	
3	30	0.400	-0.350	
4	45	0.470	-0.280	
5	60	0.550	-0.200	
6	90	0.650	-0.100	
7	120	0.680	-0.070	
8	150	0.720	-0.030	
9	180	0.730	-0.020	
10	240	0.735	-0.015	
11	300	0.740	-0.010	
12	360	0.745	-0.005	

Dillon Consulting Ltd. 1425 Bishop Street Cambridge,Ontario	slug/bail test analysis HVORSLEV's method	1, Page 1 Project: Rennie Street Landfill Evaluated by: IJH — Date: 21.05.2000

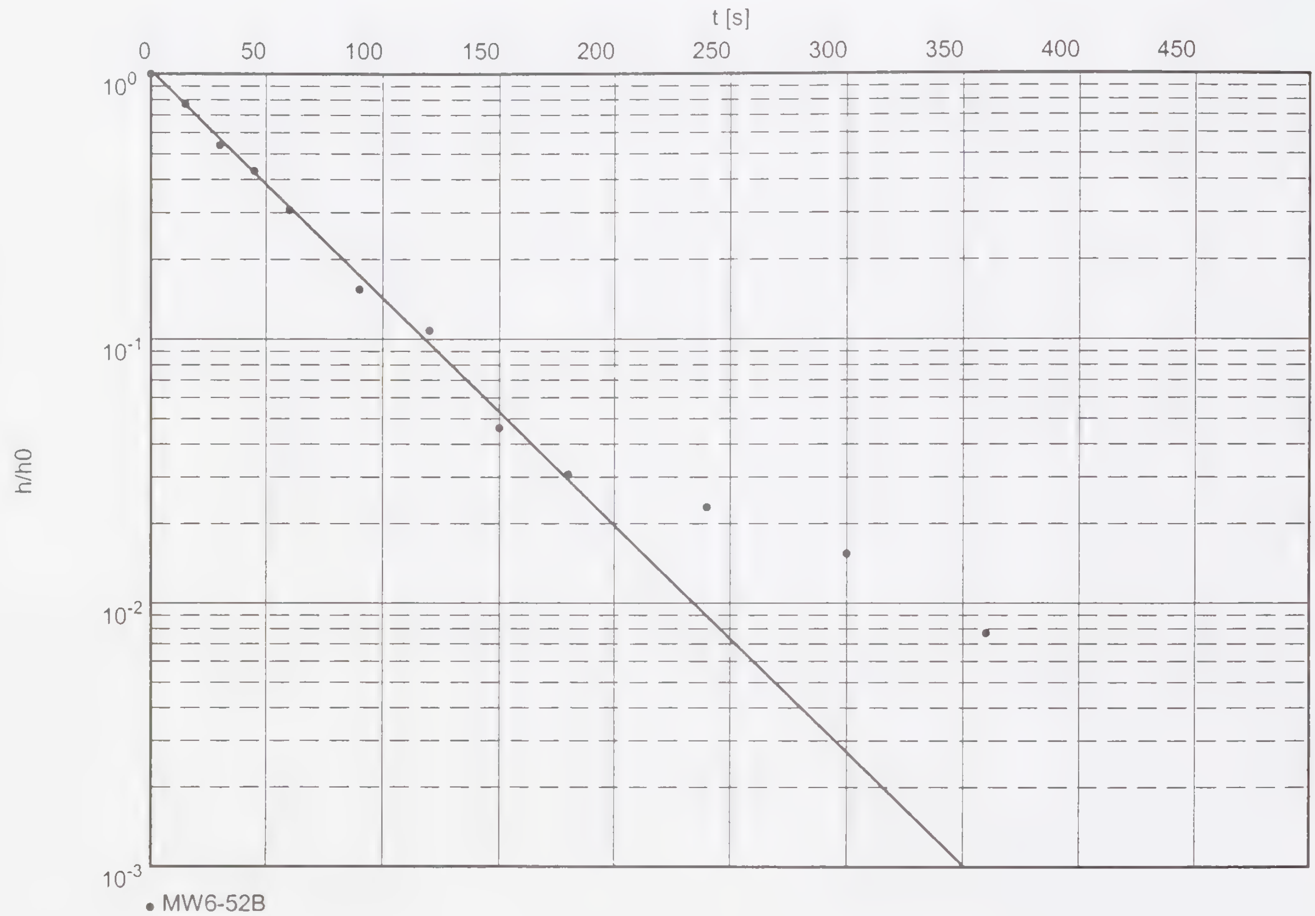
Slug Test No. 1	Test conducted on: May 18, 2000
MW6-53B	



Hydraulic conductivity [m/s]: 9.77×10^{-7}

Dillon Consulting Ltd. 1425 Bishop Street Cambridge,Ontario	slug/bail test analysis HVORSLEV's method	1, Page 1 Project: Rennie Street Landfill Evaluated by: IJH — Date: 17.05.2000

Slug Test No. 1	Test conducted on: May 13, 2000
MW52-B (deep)	



Hydraulic conductivity [m/s]: 6.82×10^{-6}

APPENDIX C

Combustible Gas Monitoring and Heath Consultant's Report

Table C-1: On-Site Gas Monitoring
Former Rennie Street Landfill

Well ID	Combustible Gas *1							
	10/13/98	11/12/98	12/2/98*2		01/26/99	02/12/1999	05/18/00 *3	07/19/00
GW1	18% Gas	12% Gas	15% Gas	15% Gas	16% Gas	5% Gas	0.1% Gas	0.2% LEL
GW2	0.3% LEL	0.4% LEL	0.0% LEL	0.0% LEL	0.4% LEL	0.0% LEL	0.0% Gas	0.2% LEL
GW3	48% Gas	39% Gas	57% Gas	50% Gas	75% Gas	63% Gas	>10% LEL	1.7% LEL
GW4	47% Gas	0.4% LEL	3.6% LEL	3.8% LEL	8% Gas	15% LEL	2% LEL	35% LEL
GW5	0.0% LEL	0.4% LEL	0.0% LEL	0.0% LEL	0.0% LEL	0.4% LEL	0.2% LEL	0.1% LEL
GW6	85% Gas	76% Gas	68% Gas	88% Gas	82% Gas	71% Gas	>10% LEL	72% Gas
GW7	-	-	-	-	-	-	0.5% LEL	0.3% LEL
MW6-57	-	-	-	-	-	-	-	32% Gas
MW6-59	-	-	-	-	-	-	-	40% Gas
MW6-60	-	-	-	-	-	-	-	2.6% LEL

NOTES:
- *1 Measured with GMI Gas Surveyor 4 calibrated for methane.
- *2 Two meters were used in December testing
- *3 The gas readings on this occasion were collected with a Microtip Photonionization detector
- LEL Lower Explosive Limit for methane (≈5% Gas)
- "–" Not measured

February 16, 1999

DILLON
CONSULTING

1425
Bishop Street,
Cambridge,
Ontario,
Canada
N1R 6J9
Telephone
(519) 623-6761
Fax
(519) 623-8805

City of Hamilton,
Department of Public Works & Traffic
City Hall, 71 Main Street West
Hamilton, Ontario
L8P 4Y5

Attention: Mr. Reg Meiers, P.Eng.

Combustible Gas Investigation Update
Vicinity of Former Rennie Street Landfill

Dear Mr. Meiers:

This letter presents the results of additional combustible gas testing in the vicinity of the Rennie Street Landfill as recommended by Dillon in our letter of January 6, 1999. The additional work involved testing existing soil gas monitors and in the on-site Public Works Yard buildings in January and February when natural venting of soil gas is prohibited due to frost.

The results of the gas monitoring are documented in Tables 1 and 2, attached. Table 1 shows that the concentrations in soil gas monitors are consistent with previous results. The exceptions is the result of 8 % Gas at GW4 in January 1999. This is higher than the November and December 1998 results but is less than the 43 % Gas measured in October 1998. The concentration at this monitor in February 1999 had decreased to 15 % LEL (Lower Explosive Limit = 5 % Gas). The February result of 5 % Gas at GW1 is lower than previous measurements at this monitor.

The results of testing in on-site buildings (Table 2) indicate relatively low concentrations (less than 1 % LEL) and are not considered to be significant.

Overall, the concentrations in soil gas monitors and on-site buildings in January and February 1999 are consistent with previous measurements and no additional testing of adjacent residences is required at this time. A long-term solution to deal with combustible gas hazards will be included in the pre-design report presently under preparation for the site. This will probably include a combination of a vertical barrier with venting on the landfill side of the barrier. An on-going combustible gas monitoring program will also be recommended in that report, to ensure the effectiveness of the proposed system.

... continued

Please call the undersigned at 519-438-6192 if you have questions regarding the results of the testing completed at the site.

Yours sincerely,

Dillon Consulting Limited

R. Kell

Rob Kell, P.Eng.
for Patsy Duever, M.A.Sc.
Project Manager

Encls.

cc: Ms. Pam Hubbard, Special Projects Office
Mr. Gary Moore, P.Eng., Special Projects Office
Mr. Bill Hunter, Health Services Department

rtk:clr/96-3564-27

Table 1

Former Rennie Street Landfill Gas Monitoring
On-Site Soil Gas Monitors

Well ID	Combustible Gas *					
	10/13/98	11/12/98	12/2/98**		01/26/99	02/12/1999
GW1	18% Gas	12% Gas	15% Gas	15% Gas	16% Gas	5% Gas
GW2	0.3% LEL	0.4% LEL	0.0% LEL	0.0% LEL	0.4% LEL	0.0% LEL
GW3	48% Gas	39% Gas	57% Gas	50% Gas	75% Gas	63% Gas
GW4	47% Gas	0.4% LEL	3.6% LEL	3.8% LEL	8% Gas	15% LEL
GW5	0.0% LEL	0.4% LEL	0.0% LEL	0.0% LEL	0.0% LEL	0.4% LEL
GW6	85% Gas	76% Gas	68% Gas	88% Gas	82% Gas	71% Gas

* Measured with GMI Gas Surveyor 4 calibrated for methane.
** Two meters were used in December testing
LEL Lower Explosive Limit for methane (≈5% Gas)

Table 2
Former Rennie Street Landfill Gas Monitoring
Public Works Yard Buildings

Building	Location	Combustible Gas*		
		12/02/98 (% LEL)	01/26/99 (% LEL)	02/12/99 (% LEL)
Office	locker room	0.0%	0.1%	0.0%
	furnace room	0.0%	0.0%	0.0%
	mens washroom	0.0%	0.0%	0.0%
	lunch room	0.0%	0.0%	0.3%
	smoking room	0.0%	0.0%	0.0%
	offices	0.0%	0.0%	0.0%
White Quonset Hut	office room & cupboards	0.0%	0.1%	0.2%
	storage room	0.0%	0.2%	0.2%
	shop area	0.0%	0.0%	0.2%
	catch basin	0.0%	0.0%	0.0%
Green Quonset Hut	four corners	0.0%	no access	no access
	storage shed adjacent to green Quonset hut	0.0%	no access	no access

\+ Measured with GMI Gas Surveyor 4 calibrated for methane
LEL Lower Explosive Limit for methane (~5% Gas)

HEATH Consultants Limited

2035 PIPER LANE
LONDON, ONTARIO N5V 3S5
TELEPHONE (519) 659-1144
FAX (519) 453-2182

January 4, 1999

Mr. Rob Kell, P. Eng.
Dillon Consulting Ltd.
Box 426, Station B
London, Ontario
N6A 4W7

Dear Mr. Kell

Re: Dillon Project Number 96-3664-27-05
Rennie St. Works Yard, Hamilton, Ontario

The attached report details the procedure and results of the methane gas testing, sample collection, and laboratory analysis for the testing conducted by Heath Consultants at your request.

Included with the report are comments and determinations made by the Union Gas lab technician who conducted the analysis. It is my understanding that this information was sent to me and that you received only the individual analysis results.

The project was conducted by Mr. Barry Smith and Mr. Jamie Chapman on December 17, 1998. Lab analysis was conducted by the Union Gas Technical Service Department in Chatham, Ontario. Analysis work was conducted on December 19 and 20th, 1998. All information pertaining to this project indexed and recorded under Heath project number 996236.

Mr. Kell, we appreciate this opportunity to be of service to you and your organization. Please contact this office if there are any concerns or questions regarding this report.

Yours truly,

Barry Smith

Barry Smith
Eastern Area Supervisor

HEATH *Consultants Limited*

Methane Gas Testing,

Sample Collection & Analysis

Conducted for:	Dillon Consulting
Location:	Rennie St. Works Yard, Hamilton, Ontario
Date:	December 17, 1998
Project No:	996236

1.0 Overview

The discussed objectives of the survey were:

1. Evaluate the spread of methane gas located on the site with regard to residences located on Waterloo St., west of the works yard.

2. Conduct an interior inspection of the buildings located at the site, using flame ionization instrumentation, to determine if gas penetration is occurring.

3. Collect bag samples from various location to determine the nature of the combustibles recorded in the soil atmosphere.

4. Test manholes and catch basins on and near the site using the flame ionization instrumentation for the presence of methane gas.

2.0 Procedure

The spread of methane on the west side of the work's yard was tested using a 40" plunger bar and a GMI combustible gas indicator. Test holes were placed at 3 to 4 metre intervals along the west fence line adjacent to properties on Waterloo Street. Bar hole tests were also conducted at suspect vegetation locations along the west paving line of the property and random locations of the grassed area.

Interior inspections were conducted of the three buildings located on site. The Heath D.P.II flame ionization instrument was used. Tests were conducted along the interior foundation walls and at any penetration points found. Penetration points include water, hydro and sewer services as well as any floor cracks or other conduits.

Tedlar sample bags of combustibles were collected using established procedures. The locations where samples were collected were predetermined. Three unknown samples and one sample of pipeline natural gas were collected. The samples were driven to the Union Gas Lab in Chatham on December 18, 1998 for analysis on December 19th and 20, 1998.

Manholes and catch basins located on site were tested using the Heath D.P.II for the presence of methane gas.

3.0 Instrumentation and Calibration

To conduct the testing two instruments were used, a GMI Gasurveyor 4 Combustible Gas Indicator, and a Heath D.P.II flame ionization instrument, with a sensitivity of approximately 1 PPM. Both instruments were calibrated against a known sample prior to conducting any tests.

4.0 Results

1. Bar Test of Soil Atmosphere

No positive readings were recorded in the soil atmosphere along the west property fence line opposite the homes on Waterloo Street.

No positive indications were recorded at the random bar test locations from the edge of the paving west to the fence line. These locations were tested based primarily on noticeable vegetation indications.

2. Interior Inspections:

Listed below are the results of the interior inspections. The low readings in the Storage Building can not be positively attributed to the methane gas in the surrounding soil atmosphere. The readings recorded in the Maintenance Barn may be a result of the painting and cleaning operations. Readings in the Office and Lockers Building would appear to be a result of the gas concentrations in the surrounding soil atmosphere.

	Public Works Storage (Northeast Building)	Maintenance Barn (South Building)	Office and Lockers (North Building)
Free Air	1 PPM	10 PPM	10 PPM
Floor Crack	1 PPM	10 PPM	500 PPM
Electrical Conduit	NEG	NEG	50 PPM
Other Conduit	-------	-------	NEG
Sewer	NEG	NEG	NEG
Water Service	NEG	NEG	NEG

Indications, in excess of 1000 PPM were recorded along the exterior east wall of the Maintenance Barn. As follow up the east wall was bar tested. Readings

from low L.E.L. to 5 % GAS were recorded. Charcoal filter testing identified heavy hydrocarbons probably diesel, opposite the diesel tank on the east side. All other indications proved to be light hydrocarbons assumed to be methane.

3. Sample Collection and Analysis

The four samples were collected as planned. Three unknown samples from GW6, GW3, and MW6-44 were collected. The known sample of pipeline natural gas was collected at the Union Gas meter located at the Maintenance Barn Building.

Analysis was conducted by the Union Gas Lab. The results of the analysis and the remarks of the technician are attached to this report. In general the concentrations of gas in the soil atmosphere are resultant of the methane gas generated from the landfill area.

4. Manholes and Catch Basins

Two manholes in the driveway opposite the Office Building recorded indications of approximately 300 P.P.M.. Readings can not be proven to be resultant of the gas from the landfill but the concentration level is higher than normally detected in storm or sanitary sewers.

5.0 Remarks

It is recommended that interior inspections be conducted during the frost period for the buildings on-site. Given the gas levels in the sewers further monitoring may be prudent. If the sewer lines running through the yard are connected to adjacent street sewers, additional testing may be of value.

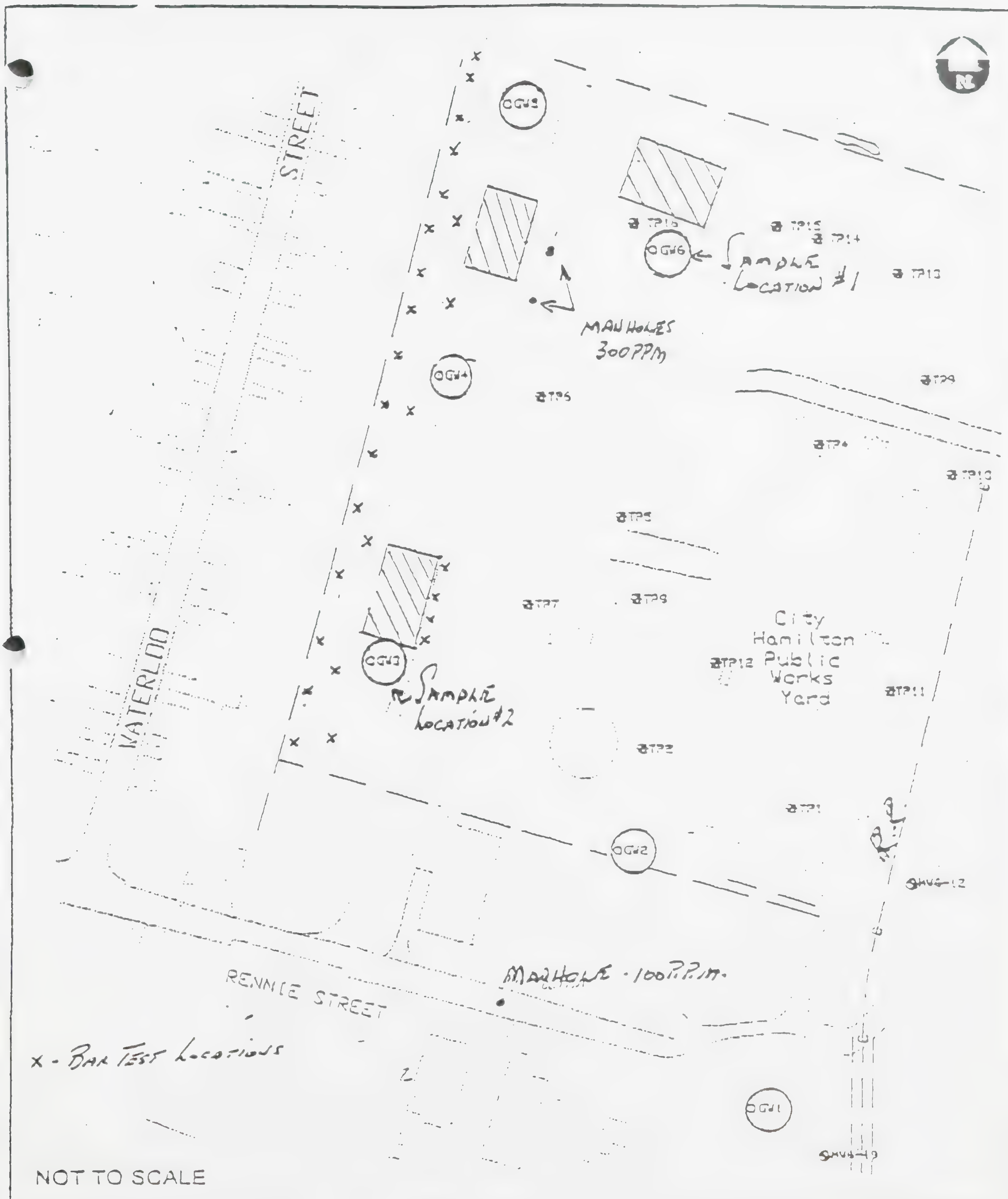
With the results of the bar testing it would not seem likely that methane gas would migrate through the soil atmosphere to the homes on Waterloo St. In the interest of public safety testing of these homes may be again considered during the frost period. It would be recommended to use flame ionization instrumentation for these inspections.

Staff on site asked Heath personnel about the placement of methane gas alarms within the Office and Locker Building and the Maintenance Barn. It was explained that readings in the Office and Locker Building were highest in the office area and the furnace room. Alarms could be placed in those two rooms close to the ceiling. For the Maintenance Barn it was suggested to place the alarm at the south end of the building.

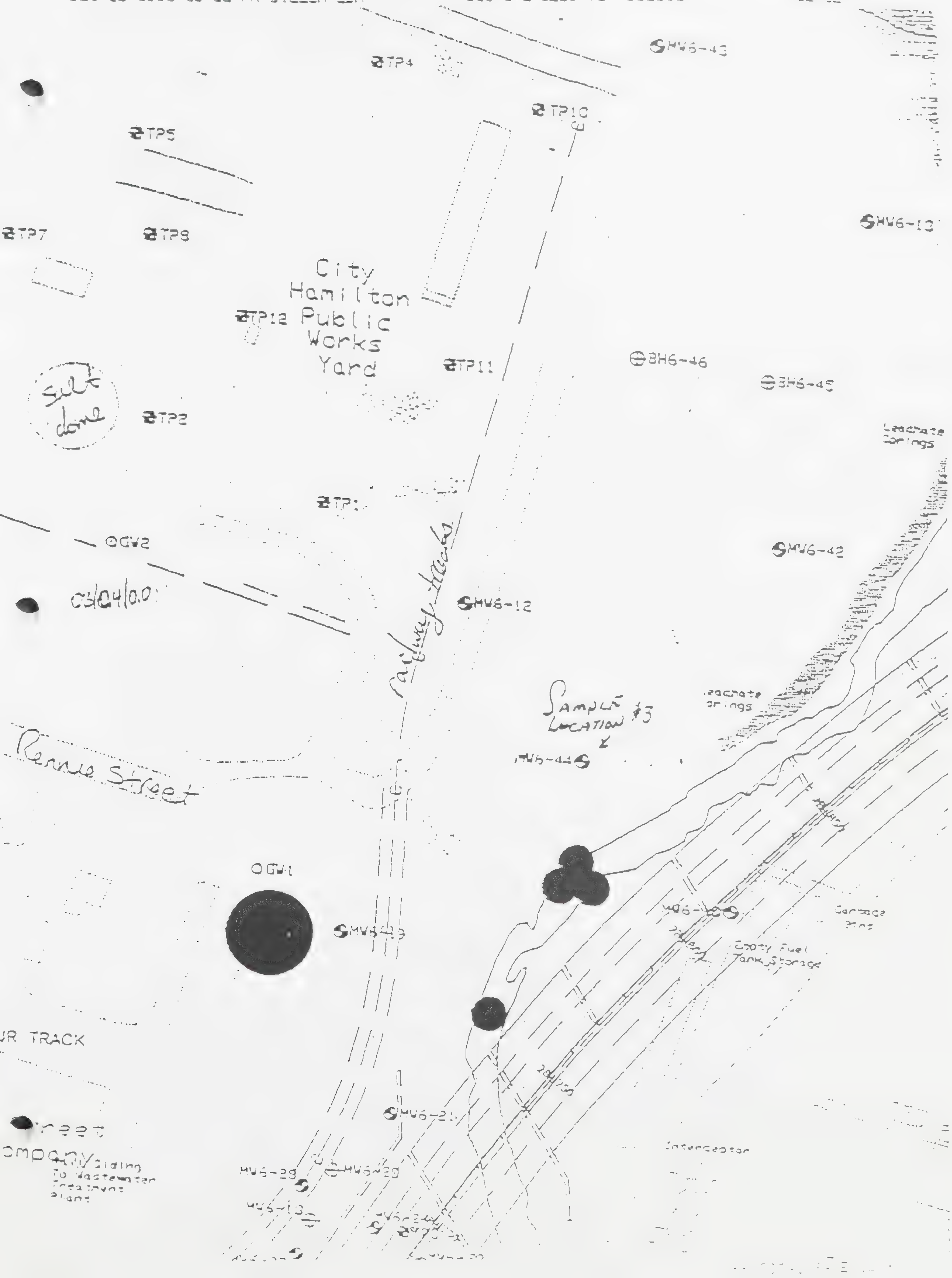
6.0 Sketch of Test Locations and Analysis Report

Following are the sketch maps identifying the bar test locations and sample collection points.

A copy of the Union Gas analysis is also attached.



DILLON CONSULTING	TITLE: LOCATION OF SOIL GAS MONITORS	PROJECT NO. 96-3564-27
DATE: DECEMBER 1998	PROJECT: RENNIE STREET WORKS YARD	FIGURE No. 1


HW6-43
TP4
TP10
TP5
TP7
TP8
HW6-13
City
Hamilton
Public
Works
Yard
TP12
TP11
BH6-46
BH6-45
Salt dome
TP2
Leachate Springs
TP1
OGW2
HW6-42
03/04/00
railway tracks
HW6-12
Sample Location #3
Leachate Springs
HW6-44
Rennie Street
OGW1
HW6-19
Garbage Bins
Empty Fuel Tank Storage
HW6-21
Interceptor
HW6-28
HW6-29
HW6-13

Barry Smith
Heath Consultants Limited.
2085 Piper Lane,
London, Ontario.
Tel. #(519)659-1144.
Fax #(519)453-2182.

December 21, 1998.

Re: Heath Project: P.O. #990037

Barry,

Samples from Hamilton (Public Works Yard) Pannier St. were received for analysis from Jamie Chapman 98/12/18. Four Tedlar samples, 3-unknown + 1-reference sample of pipeline gas were analyzed 98/12/19. All of the provided samples were leak checked and found to be O.K. All of the provided samples total combustibles were very close to what was indicated for each sample provided.

As requested, the analysis results will be faxed to Rob Kell (Dillon Consulting) Fax #(519) 672-8209.

<u>Sample #1:</u>
Location: "GW6"
Sample ID: c-ham812.smp
Total combustible concentration indicated as 85%.

This sample consists of 79.876330 mole%, 1507.1% of the L.F.L. or 798763 ppm by mole, combustibles. The analytical report indicates very high carbon dioxide within a definite natural gas sample. The major combustible compound detected is methane with trace concentrations of C2 to C5 organic aliphatic saturated hydrocarbons. There does not appear to be any detectable VOC's within this sample. The chromatographic signature suggests a natural reduction in the C2 to C5 hydrocarbon cluster region. This is consistent with a type of natural thermogenic/petrogenic origin. The ratios of the minor analytes expressed to the major compound methane suggest there is a high probability this sample is originating from other than a Union Gas pipeline system. There may thermogenic influence due to the detection of C2 to C5 hydrocarbons. There may be biogenic/microbile influence due to the high CO2 detected. Please refer to the provided analytical report for comparison.

<u>Sample #2:</u>
Location: "GW3"
Sample ID: cham812a.smp
Total combustible concentration indicated as 55%.

This sample consists of 54.368567 mole%, 1045.3% of the LFL or 543686 ppm by mole, combustibles. The analytical report indicates considerably less CO2 with respect to sample #1 but still a substantial concentration. Other than a lower combustible concentration plus less CO2 with respect to sample #1, this sample appears to be of the same origin as samples #1, #3.

<u>Sample #3:</u>
Location: " MW6-44"
Total combustible concentration indicated as 51%.

This sample consists of 52.418924 mole%, 989.037% of the L.F.L. or 524189 ppm by mole, combustibles. The analytical report indicates considerably less CO2 than sample #1 but substantially more than sample #3. Other than a lower combustible concentration than sample #1 & sample #2 plus less CO2 than sample #1 and more CO2 than sample #2, this sample appears to be of the same origin as samples #1,#2.

Sample #4:
Location: Union Gas meter "Rennie St. Work Yard"
Total combustible concentration indicated as 100% pipeline gas.

This sample consists of 98.694488 mole%, combustibles.

Conclusions:

There is a high probability samples #1,2,3 are not being influenced by sample #4 (pipeline gas). This is based on the premise there is no ground absorption or chromatographic action taking place on the minor or major compounds of interest within the traveled medium.

The three unknown samples are more than likely all from the same origin due to a similar chromatographic signatures. Samples #1 & #2 both contain more n-C4 & n-C5 with respect to i-C4 & i-C5. All three samples contain relatively high CO_2 concentrations. The C2 to C5 ratios developed to the major compound are slightly different but close enough to suggest similar origin. The difference may be due to the distance of each sample from the origin gas.

The suspected thermogenic influenece is based on the detection of C2 to C5 hydrocarbons. The thermogenic source is based on the premise these compounds are created in higher C+ as the temperature & pressure of the origin increases. It is not known whether a landfill is deep enough or able to produce enough temperature and pressure in order to duplicate a natural gas similar to a typical natural thermogenic origin.

The above four samples were analyzed using an air13 method with two primary standards for calibration. A high sensitivity method or a higher sensitivity method is possible. The 02/N2 values reported in sample 2,3 ~~#1,2~~ will be < actual due the type of standards used. This explains the low accountability percentage for these samples. This will not affect the conclusions or the other compounds. The CO_2 reported will more in likely be > than reported due to the type of standards used.

Mike Regnier
Gas Measurement
Technical Services
Union Gas Limited
Tel. #(519)352-3100 ext. 2745
Fax #(519)436-5299

int Date: Sat Dec 19 10:08:34 1998

HEATH SAMPLE #1
LOCATION → "GW6"
S/B 83% COMBUSTIBLE

t :
n File : C:\Star\module16\gas025.run
ethod File : c:\star\air18.mth
mple ID : c-ham812.smp

njection Date: 12/19/98 8:20 AM Calculation Date: 12/19/98 9:50 AM

perator : M.Regnier
orkstation:
nstrument : Varian Star #1
hannel : A = A

Detector Type: ADCB (1 Volt)
Bus Address : 16
Sample Rate : 10.00 Hz
Run Time : 67.502 min

* Star Chromatography Workstation Version 5.0 ** 00364-5F08-D91-23AC **

un Mode : Analysis
eak Measurement: Peak Area
alculation Type: External Standard

Peak No.	Peak Name Ratio ÷ CH4	Result () MOLE%	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)	Status Codes
✓1	He ~~NOT DETECTED~~	0.000000	0.072	0.000	14466	BB	5.1	
✓2	H2 ~~NOT DETECTED~~	0.000000	1.711	0.000	2407	BV	3.7	
✓3	CO2- 1:8.1	9.850634	1.788	-0.002	8193609	VB	3.8	C
✓4	O2 - 1:30.9	2.580467	2.753	-0.014	1605600	BV	2.6	C
5	N2 - 1:9.5	8.414396	3.055	-0.045	6086932	VV	5.3	C
6		0.000000	3.743	0.000	24670402	VB	23.6	
✓7	CH4- 1:1	79.855629	5.905	0.003	915085	BB	1.9	
✓8	C2H6- 1:6659.1	0.011992	6.498	0.007	299	BB	1.4	
✓9	C3H8- 1:14240	0.005608	9.040	0.042	207	BB	1.8	
✓10	ISO-C4+ 1:188339	0.000424	13.574	0.025	202	BB	2.1	
✓11	N-C4+ - 1:52885	0.001510	14.093	0.023	754	BB	2.1	
✓12	1-C4= - 1:313159	0.000255	16.674	0.351	120	BB	2.0	
✓13	ISO-C5+ 1:187455	0.000426	18.235	0.020	247	BB	2.1	
✓14	N-C5+ - 1:164312	0.000486	18.627	0.019	277	BB	2.1	
	Totals:	100.721827		0.429	41490607			

TOTAL COMBUSTIBLES = 79.876330 MOLE%. ✓

Status Codes:
C - Out of calibration range

Total Unidentified Counts : 24687274 counts

Detected Peaks: 16 Rejected Peaks: 2 Identified Peaks: 11

Multiplier: 1 Divisor: 10000 Unidentified Peak Factor: 0

Baseline Offset: 73 microVolts

Noise (used): 30 microVolts - fixed value
Noise (monitored before this run): 41 microVolts

Manual injection

Calib. out of range; No Recovery Action Specified

Error Log:

-

nt Date: Sat Dec 19 10:08:34 1998

)0 C:

: Board:

iginal Notes:

Hamilton sample #1 (Heath for Dillon Consulting) Rennie St., location: "GW6" S.D. 98/12/17. Sample S/B 83% combustibles. Taken by Barry Smith. Del. 98/12/18-Jamie.

pended Notes:

****

it Date: Sat Dec 19 11:16:45 1998

Page 1 of 2

HEATH SAMPLE #2
LOCATION → "GW3"
S/B 55% COMBUSTIBLES.

Le :
File : c:\star\module16\gas026.run
hod File : c:\star\air18.mth
ple ID : cham812a.smp

ection Date: 12/19/98 10:02 AM   Calculation Date: 12/19/98 11:10 AM

rator : M.Regnier
kstation:
trument : Varian Star #1
nnel : A = A

Detector Type: ADCB (1 Volt)
Bus Address : 16
Sample Rate : 10.00 Hz
Run Time : 67.502 min

Star Chromatography Workstation Version 5.0 ** 00364-5F08-D91-23AC **

Mode : Analysis
k Measurement: Peak Area
culation Type: External Standard

eak No.	Peak Name	Result () MOLE%	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)	Status Codes
1		0.000000	0.072	0.000	14351	BB	5.1	
2		0.000000	0.754	0.000	42	BV	1.0	
3	HE - 1:34460	-0.001592	0.863	0.002	311	VV	4.1	
4	H2 — 1:82497	-0.000665	0.945	0.003	217	VB	2.6	
[illegible]	CO2 - 1:30.9	-1.774899	1.916	0.126	1476335	BB	6.3	C
6	O2 - 1:14.345	-3.824505	2.731	-0.036	2379657	BV	3.1	C
7	N2 — 1:2.762	-19.817596	3.023	-0.077	14335949	VV	13.3	C
8		0.000000	3.792	0.000	19704454	VB	23.6	
9	CH4- 1:1	-54.860825	5.915	0.012	628664	BB	1.7	
10	C2H6-1:12827	-0.004277	6.501	0.010	107	BB	1.4	
11	ISO-C4+ 1:234442	-0.000234	13.577	0.028	111	BB	2.0	
12	N-C4+ - 1:52298	-0.001049	14.099	0.029	524	BB	2.1	
13	1-C4= - 1:322711	-0.000170	16.680	0.357	30	BB	1.9	
14	ISO-C5+ 1:52700	-0.001041	18.240	0.024	603	BB	2.2	
15	N-C5+ - 1:179284	-0.000306	18.634	0.026	174	BB	2.1	
	Totals:	80.287159		0.504	38541579			

Σ COMBUSTIBLES = 54.862567 MOLE%

atus Codes:
- Out of calibration range

tal Unidentified Counts : 19713848 counts

etected Peaks: 18   Rejected Peaks: 3   Identified Peaks: 12

ltiplier: 1   Divisor: 10000   Unidentified Peak Factor: 0

aseline Offset: 9 microVolts

oise (used): 30 microVolts - fixed value
oi (monitored before this run): 34 microVolts

anual injection

alib. out of range; No Recovery Action Specified

rror Log:

0C:

C Board:

iginal Notes:

Hamilton sample #2 (Heath for Dillon Consulting) Rennie St., location: "GW3" S.D. 98/12/17. Sample S/B 55% combustibles. Taken by Barry Smith. Del. 98/12/18-Jamie.

****

rint Date: Sat Dec 19 12:47:09 1998

HEATH SAMPLE #3
LOCATION → "MW6-44"
S/B 51% COMBUSTIBLES

itle :
un File : c:\star\module16\gas027.run
ethod File : c:\star\air18.mth
ample ID : cham812b.smp

njection Date: 12/19/98 11:36 AM   Calculation Date: 12/19/98 12:44 PM

perator : M.Regnier
orkstation:
nstrument : Varian Star #1
hannel : A = A

Detector Type: ADCB (1 Volt)
Bus Address : 16
Sample Rate : 10.00 Hz
Run Time : 67.502 min

* Star Chromatography Workstation Version 5.0 ** 00364-5F08-D91-23AC **

un Mode : Analysis
eak Measurement: Peak Area
alculation Type: External Standard

Peak No.	Peak Name	Result ()/MOLE%	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)	Status Codes
1		0.000000	0.074	0.000	14306	BB	5.1	
2		0.000000	0.763	0.000	66	BV	0.0	
✓3	HE- 1:95781	-0.000547	0.864	0.003	107	VV	1.9	
✓4	H2- 1:2160.4	-0.024251	0.945	0.003	7935	VB	1.8	
5	CO2- 1:9.759	-5.368690	1.339	0.049	4465596	PB	7.3	C
✓6	O2- 1:6.273	-8.352417	2.728	-0.039	5196982	BV	4.7	C
✓7	N2- 1:2.872	-13.240425	3.032	-0.068	13195031	VV	12.2	C
8		0.000000	3.797	0.000	19103156	VB	23.1	
✓9	CH4- 1:1	-52.392342	5.916	0.013	600377	BB	1.6	
✓10	C2H6-1:22476	-0.002331	6.502	0.011	58	BB	1.3	
	Totals:	84.381003		-0.028	42583614			

TOTAL COMBUSTIBLES = 52.418924 MOLE%..

Status Codes:
C - Out of calibration range

Total Unidentified Counts : 19117528 counts

Detected Peaks: 12   Rejected Peaks: 2   Identified Peaks: 7

Multiplier: 1   Divisor: 10000   Unidentified Peak Factor: 0

Baseline Offset: 88 microVolts

Noise (used): 30 microVolts - fixed value
Noise (monitored before this run): 25 microVolts

Manual injection

Calib. out of range; No Recovery Action Specified

Error Log:

3400 GC:

ADC Board:

:int Date: Sat Dec 19 12:47:09 1998

:iginal Notes:

Hamilton sample #3 (Heath for Dillon Consulting) Rennie St., location "MW6-44" S.D. 98/12/17. Sample S/B 51% combustibles. Taken by Barry Smith. Del. 98/12/18-Jamie.

****

rint Date: Sat Dec 19 14:32:35 1998

HEATH SAMPLE #4
LOCATION: UNION GAS PIECE
"LENNIE ST. WORK YARD"
5/8 100% PIPELINE GAS

tle :
un File : c:\star\module16\gas028.run
ethod File : c:\star\air18.mth
ample ID : cham812c.smp

njection Date: 12/19/98 1:21 PM Calculation Date: 12/19/98 2:28 PM

perator : M.Regnier
orkstation:
nstrument : Varian Star #1
hannel : A = A

Detector Type: ADCB (1 Volt)
Bus Address : 16
Sample Rate : 10.00 Hz
Run Time : 67.502 min

* Star Chromatography Workstation Version 5.0 ** 00364-5F08-D91-23AC **

un Mode : Analysis
eak Measurement: Peak Area
alculation Type: External Standard

Peak No.	Peak Name	Result ()	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)	Status Codes
1		0.000000	0.072	0.000	14490	BB	5.1	
✓ 2	HE- 1:2344.7	-0.040830	0.857	-0.004	7976	BP	1.4	
✓ 3	H2- 1:85477	-0.001120	0.939	-0.003	366	PB	0.0	
✓ 4	CO2- 1:151.9	-0.630123	1.934	-0.033	524127	BB	6.5	
✓ 5	O2- 1:666.5	-0.143630	2.766	-0.001	89369	BV	0.0	
6		0.000000	3.008	0.000	49	TS	0.0	
7	N2- 1:47.9	-1.998377	3.095	-0.005	1445616	VV	3.1	
8		0.000000	3.516	0.000	209	TS	0.0	
9		0.000000	3.721	0.000	27379400	VB	31.4	
✓ 10	CH4- 1:1	-95.734306	5.397	-0.006	1097043	BB	1.9	
✓ 11	C2H6- 1:34.4	-2.782913	6.485	-0.006	69489	BB	1.5	
✓ 12	C3H8- 1:672.3	-0.142297	9.025	0.027	5246	BB	2.0	
✓ 13	ISO-C4+ 1:7728.3	-0.012292	13.575	0.026	5360	BB	2.2	
✓ 14	N-C4+ 1:7457.1	-0.012838	14.099	0.029	6412	BB	2.2	
✓ 15	ISO-C5+ 1:25488	-0.003756	18.249	0.034	2177	BB	2.3	
✓ 16	N-C5+ 1:39300	-0.002436	18.646	0.038	1387	BB	2.2	
✓ 17	Group (C6+) 1:37840	0.002530	44.250	0.000	1708	GR	0.0	
	Totals:	101.507443		0.096	30650924			

TOTAL COMBUSTIBLES = 98.694488 ✓

Total Unidentified Counts : 27394148 counts

Detected Peaks: 24 Rejected Peaks: 4 Identified Peaks: 13

Multiplier: 1 Divisor: 10000 Unidentified Peak Factor: 0

Baseline Offset: 23 microVolts

Noise (used): 30 microVolts - fixed value
Noise (monitored before this run): 42 microVolts

Manual injection

Error Log:

3400 GC:

ADC Board:

Original Notes:

Hamilton sample #4 (Heath for Dillon Consulting) Rennie St., location: "Rennie St. Works Yard" Union Gas Meter. 100% pipeline gas. S.D. 98/12/17. B. Smith /Jamie.

****

APPENDIX D

Geophysics Reports

Hyd-Eng®
GEOPHYSICS INC.

November 19, 1998

Hyd Eng Ref: TK051

Mr. Sean Salvatori
Dillon Consulting Limited
100 Sheppard Ave. East, Suite 300
North York, Ontario
M2N 6N5

Phone: (416) 229 4646
Fax: (416) 229 4592

Dear Mr. Salvatori:

Please find accompanying this letter the report submittal from Hyd-Eng Geophysics Inc. entitled:

A report on an
EM31 Survey
conducted about the
Hamilton Works Yard,
Hamilton, Ontario

I trust you will find the results useful for your ongoing investigations at the site. If any questions arise, please do not hesitate to contact us.

Yours Sincerely,
Hyd-Eng Geophysics Inc.

David Coulter, P.Eng.

File\\G:\Documents\REPORTS\tk051brev.doc

Rvw-P.P.

INTRODUCTION

Hyd-Eng Geophysics Inc. (Hyd-Eng) was contracted by Dillon Consulting Limited to conduct a geophysical investigation about a former landfill ("Rennie Street Landfill") approximately located at the active Hamilton works yard, Hamilton, Ontario. The investigation was specifically undertaken to identify anomalous geophysical data that may aid in identifying the lateral extent of landfilling within the survey area.

SCOPE OF WORK

An electromagnetic (EM31) geophysical survey was conducted about the Hamilton works yard, an area that is approximately 6.5 hectares in size. The eastern portion of the yard is known to comprise part of the former "Rennie Street Landfill". However, the western extent of filling is unknown.

The geophysical survey was primarily undertaken to delineate geophysical variations indicative of anomalous soil/porewater conditions and/or buried metal. These variations may then be related to the possible limits of the decommissioned landfill suspected to extend westward into the survey area.

A Global Positioning System was used in conjunction with the electromagnetic instrument. This combination allows the operator to adjust the survey area 'real-time' as dictated by site conditions and anomalous readings encountered.

PHYSICAL PROPERTIES

The measurement of variations in the physical properties of geological units is the basis of all geophysical surveys. One of the electrical properties of a material that can be measured is its electrical conductivity (milliSiemens/metre). In general, a saturated clay overburden will have an apparent conductivity (typically ranging from 30 to 60 mS/m). A clean sand, or compact sandy/silty till unit has a conductivity, ranging from 1 to 10 mS/m. Factors such as porewater conductivity, porosity, degree of saturation, compaction, and mineralogy, control the bulk material conductivity and can cause

variations beyond natural limits. "Leachate" from most landfills will tend to have a significantly higher electrical conductivity when compared to 'clean and natural' groundwater. Typically, the leachate will contain chloride ions and other dissolved species, which will increase the conductivity of the groundwater. Consequently, as leachate moves through the ground it tends to increase the naturally occurring bulk apparent conductivity of the subsurface. This conductivity contrast between material saturated with natural groundwater and that portion of the ground containing conductive leachate ('plume') allows the contaminant to be mapped by measuring the changing electrical properties (conductance) of the subsurface.

It should be noted that detection and/or recognition of geophysical anomalies indicative of 'landfilling' and/or conductive contaminant is highly site specific and is dependent on the number of factors. These factors include the concentration of the fill/contaminate; it's depth and thickness, native materials present, as well as local sources of EM or electrical interference ("noise").

If the subsurface is so conductive so as to cause instrument readings to increase above the levels expected from natural materials, designating an area as geophysically anomalous is relatively uncomplicated. However, in many cases the identification of subtle conductivity or inphase variations as anomalous can be difficult and depends heavily on pattern recognition. In the case of a conductive 'plume', the pattern would normally include a connection to the source, and a trend of decreasing conductivity values extending away from the source(s). However, the limits of the "anomalous" zone cannot be identified without first defining what is <u>not</u> anomalous (i.e. "background".) Often in the case of fill it is the irregularity of the response that is the indicative parameter rather than the absolute value.

Background apparent conductivity can vary considerably depending on geologic variations, and changes in the water table depth. For example, if water conductivity were uniform throughout the site, areas where the water table is shallow (ex. near surface water, or moist low lying ground, such as was noted throughout portions of the survey

area) will tend to have higher conductivity readings when compared to areas that are topographically elevated.

Defining “background” conditions would be complicated, and the pattern of leachate migration from the landfill more difficult to define, if porewater, which has not been influenced by the presence of the landfill, also had a variable conductivity.

It is unlikely that the limits of anomalous zones, as inferred from the geophysical data, will correlate exactly with ‘real’ limits of landfilling or contaminant migration based on accepted standards. The geophysical anomalies will however be relatively indicative of ‘significant landfilling’ increased porewater/soil conductivity and therefore the direction of possibly existing conductive leachate migration.

Many forms of groundwater contamination typical of landfill leachate are not electrically conductive and will not be mapped by geophysical techniques. Each of these contaminants will have its own plume of concentration depending on mobility, adsorption and a variety of other factors. Fortunately the “conductivity plume” is typically one of the most mobile of these plumes and therefore provides a conservative indication of contaminant migration.

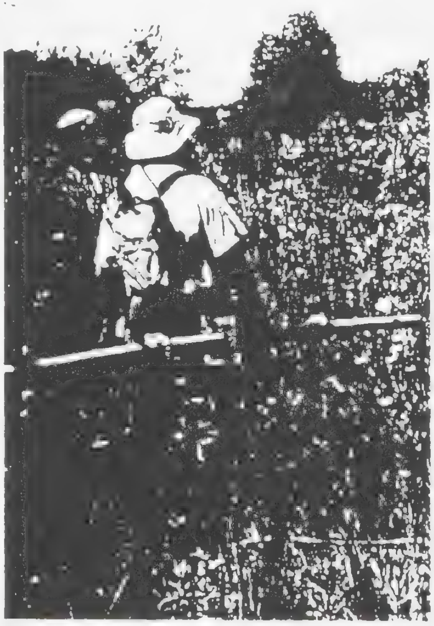
EQUIPMENT AND THEORY

This survey was carried out with the GEONICS EM31 and a Trimble Global Positioning system (GPS).

The EM31 instrument is a frequency domain electromagnetic device designed for measuring apparent conductivity and is also well suited for buried metal detection. The EM31 utilises the principle of electromagnetic (EM) induction to measure the electrical properties of the earth.

This instrument generates an electromagnetic (EM) field by passing a current through a transmitter coil. As the field passes through the ground it induces a small current flow within the ground. These ground currents create a secondary EM field in the ground. The receiver coil then measures the combined primary (produced by instrument) and secondary EM field (produced by encompassing materials). The instrument then converts the EM field properties into quadrature (apparent conductivity) measurements of the subsurface in units of milliSiemens per metre (mS/m) and inphase measurements in parts per thousand (ppt). The value for the bulk apparent conductivity of the ground represents a roughly hemispherical volume of radius 5 to 6 metres centred at the operator. The inphase response is sensitive to metal and relatively insensitive to changes in the apparent conductivity of the ground. However, extremely high ground conductivity will affect the inphase values. The quadrature response is somewhat affected by metal.

Figure 1: EM31 with GPS backpack



For a complete description of the theory of operation and technical details of the EM31 refer to McNeill, 1980.[1]

A Global Positioning System (G.P.S.) was carried, , in conjunction with the EM31 and was used to record the position of each individual EM31 data point. The GPS system consisted of a Trimble® Pathfinder Pro XL receiver and a TDS-2 Data Collector. The

---

[1] McNeill, J.D. 1980, Electromagnetic Terrain Conductivity Measurements at Low Induction Numbers, Geonics Ltd., Note TN-6, 16pp.

system has a link with Coast Guard base stations and provides real time differentially corrected position data. Tests .

FIELD PROCEDURES

The geophysical survey grid was established at the site (Figure 1) using a fenceline along the western limits of the site as a local Base line. Several Tie lines were also established parallel to additional existing fencelines. These tie lines allowed the operator to maintain a consistent line direction and spacing, thereby ensuring adequate and proper data coverage.

Using the Base and Tie line markers as a guide, EM31 and GPS data were collected simultaneously at approximately at a 0.75 metre station spacing along lines spaced approximately 5 meters apart.

DATA PROCESSING

Upon completion of each survey day, the EM31 and GPS data were transferred from the data loggers to a portable computer. The GPS data were then merged with the EM31 data to provide sub-metre accuracy in locating stations.

These data were then sorted, gridded, contoured, and plotted at an appropriate scale using *Geosoft* software, a data presentation program developed by Geosoft Limited of Toronto, Ontario.

The results of the EM31 survey are displayed as colour, contoured plots of the apparent conductivity (Fig.2) and inphase (Fig.3) data. A consistent colour scheme was, used between all EM31 surveyed area, chosen so as to highlight variations in the data. The EM31 data are also displayed as colour, contoured plots of the apparent conductivity and inphase data. The data were coloured and contoured to represent the complete

range of values. Background values are generally shown in yellow and green. Red and blue colours represent anomalous readings above and below background, respectively.

A shaded relief diagram of the EM31 inphase data is also presented. This diagram is produced by treating the data as a three dimensional surface and digitally shinning a "sun" on to it. This technique is useful to detect subtle trends in the data that are not prominent in the colour presentation.

Interference from surface metal, strapping, buildings, etc. will affect the instruments' response to nearby subsurface anomalous features. When the extent of this interference is unknown, buried features located adjacent to or directly below the source of interference may go undetected.

RESULTS

Anomalous areas *not* attributed to cultural interference, or other explainable sources, are highlighted on the interpretation maps (Figure 5a and 5b). Note that definitive background have not been established in the geophysical data. Although limited areas of relatively lower conductivity values are noted, these are dispersed between broad zones of extremely high conductivity and cannot be established as "natural". However, for interpretative purposes a background conductivity value of 35 to 40 mS/m has been estimated for the interpretation of the data. This background value is typical for a silt to silty clay material. Inphase background values range between 1 and 4 ppt across the site. Areas that have conductivity and inphase readings which deviate significantly from these background values are generally considered anomalous and are labeled on the interpretation figure with the letters "C" and "I" respectively.

A number of factors influence the size of an anomaly including depth of burial, type of fill (background values), cultural interference, and the instruments orientation relative to the object. The interpreted results of the geophysically surveyed area are discussed below.

Due to the size and number of anomalous zones and features encountered, the anomalies are divided into groups based on similar response and characteristics.

C1 and ***C2*** designate broad regions of extremely elevated apparent conductivity (>100 mS/m) and inphase (> 15ppt) data. These anomalous regions are interpreted to result from anomalous soil/fill material; porewater conductivity; and possibly buried metallic objects of varying shape, size, and depth of burial. The location and gradient of **C2** implies that it is likely the result of conductive porewater moving from the salt dome.

C3, C4 and ***C5*** designate broad regions of slightly to moderately elevated apparent conductivity (50 to 100 mS/m) and inphase (5 to 15ppt) data. These anomalous zones surround the extremely elevated regions, **C1** and **C2**. These weaker zones are interpreted to most likely result from elevated porewater conductivity and anomalous soil/fill material. Buried metal may also exist beneath these zones, but to a lesser degree when compared to areas **C1** and **C2**.

I1 defines a region of elevated inphase data with only a minor change in apparent conductivity. This zone is interpreted to result from anomalous soil/fill material, which likely has a 'disseminated' metal component.

L1 through ***L3*** are three examples of numerous linear trends which appear in the inphase and/or apparent conductivity data. These elongated features are interpreted to result from buried pipes, utilities or similar linear objects (foundations, trenches). The varying strength (ex. **L1** verses **L3)** of the EM31 response likely indicates a change in material, depth of burial, or construction. A strong response (ex. L1-solid line on Figure5a) likely indicates the presence of several metallic/conductive pipes/cables whereas a weak response (L3-dashed line on Figure 5a) likely indicates the presence of a nonconductive or deeply buried pipe/utility or former excavation.

M1 through ***M4*** are four examples of numerous anomalies which are primarily scattered about the eastern extent of the site. The signature, shape and gradient of these anomalies highly suggest the presence of buried metallic objects of varying shape, size, and depth of burial.

As the primary objective of the geophysical survey was to delineate the most likely lateral extent of buried waste/fill indicative of former 'landfilling', a second interpretation map, Figure 5b, is presented. This figure presents the interpreted limits of 'landfilling' based on a comparison of the non-intrusive geophysical data interpretation, discussed above, to local intrusive test pit information provided by Dillon Consulting Limited. Areas that have an anomalous geophysical response *and* include test pits in which 'waste' material was observed are labeled '***Z1***' on Figure 5b. Areas that have a weak to nonexistent geophysical anomalous response but 'waste' material was noted in the region are labeled '***Z2***'.

The ***Z1*** zone likely reflects the presence of a significant/thick component of waste material in the overburden, while the **Z2** zones likely reflects the presence of a minor/thinner component of waste material. It is also possible that the **Z2** zones indicate areas where the waste material is predominantly inert, such as glass and paper, which would have little or no anomalous geophysical response. Since these areas include the assumed "background" conductivity values it is possible that these zones are in actuality moderately anomalous and that no true background values exist within the survey area.

The western limit of interpreted 'landfilling' is qualitative. Much of the western portion of the survey area is dominated by the extremely conductive zone **C2** which is likely attributable to salt contamination. The presence of this anomally, as well as surface metal and the postulated thinning out of waste/fill material to the west does not permit the representation of a definitive boundary. However, the location of the interpreted

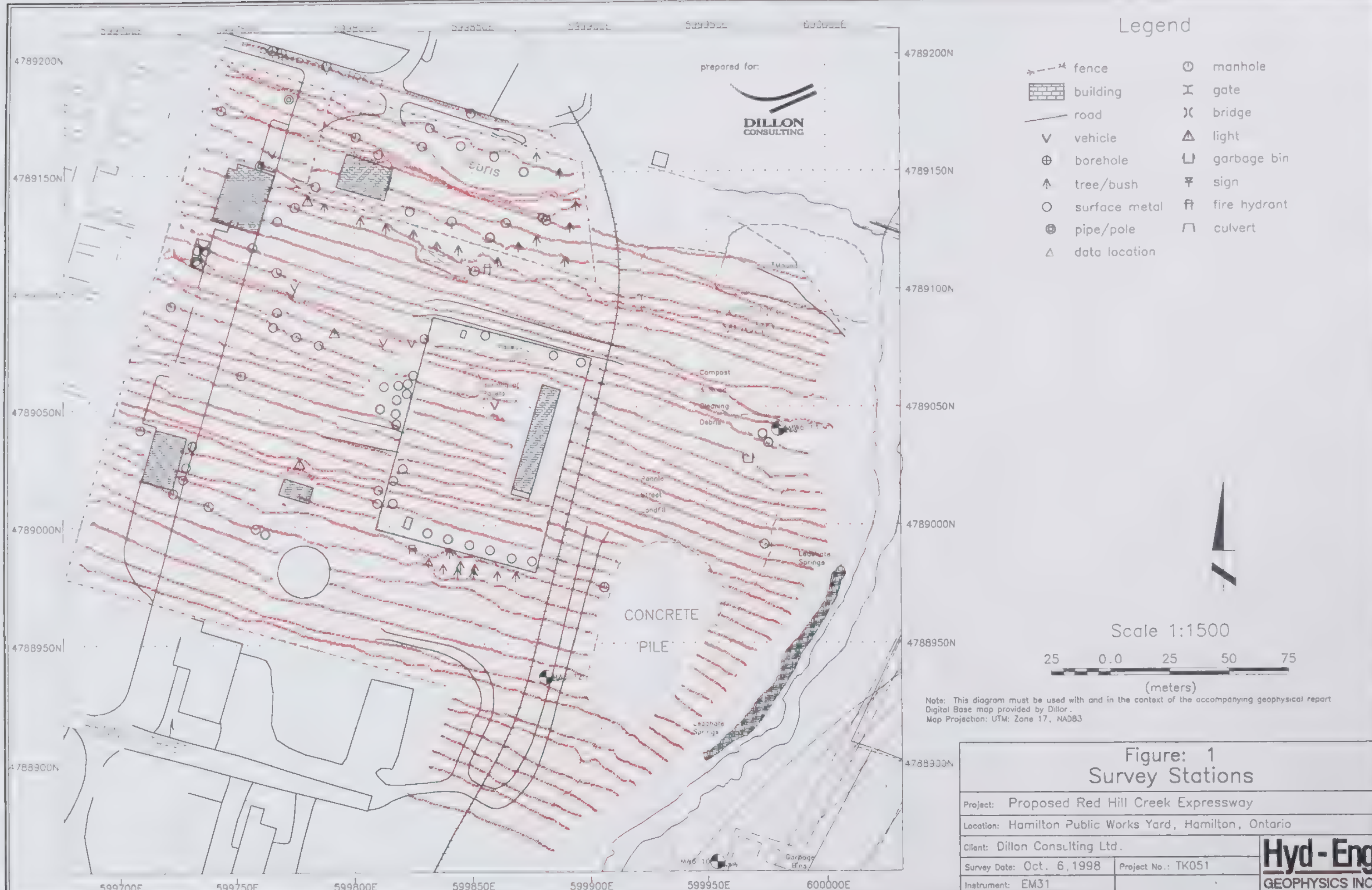
boundary on Figure 5b correlates well with observed test pit information and general trends observed in the geophysical data.

LIMITATIONS OF REPORT

This report was prepared by Hyd-Eng Geophysics Incorporated for Dillon Consulting Limited . The material in it reflects Hyd-Eng's best judgement in context of the information available to it at the time of preparation. This report is based on data and information collected during the investigation conducted by Hyd-Eng Geophysics Inc. personnel and is based solely on the conditions of the property at the time of the site reconnaissance, as described in this report. No intrusive, or direct sampling was conducted as part of this survey.

Any use which a third party makes of this report, or any reliance on or decision to be made based on it, are the responsibilities of such third parties. Hyd-Eng accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

Hyd-Eng makes no warranty, expressed or implied, and assumes no liability with respect to the use of information contained within this report. No changes to the report form or content may be made without Hyd-Eng's written approval.

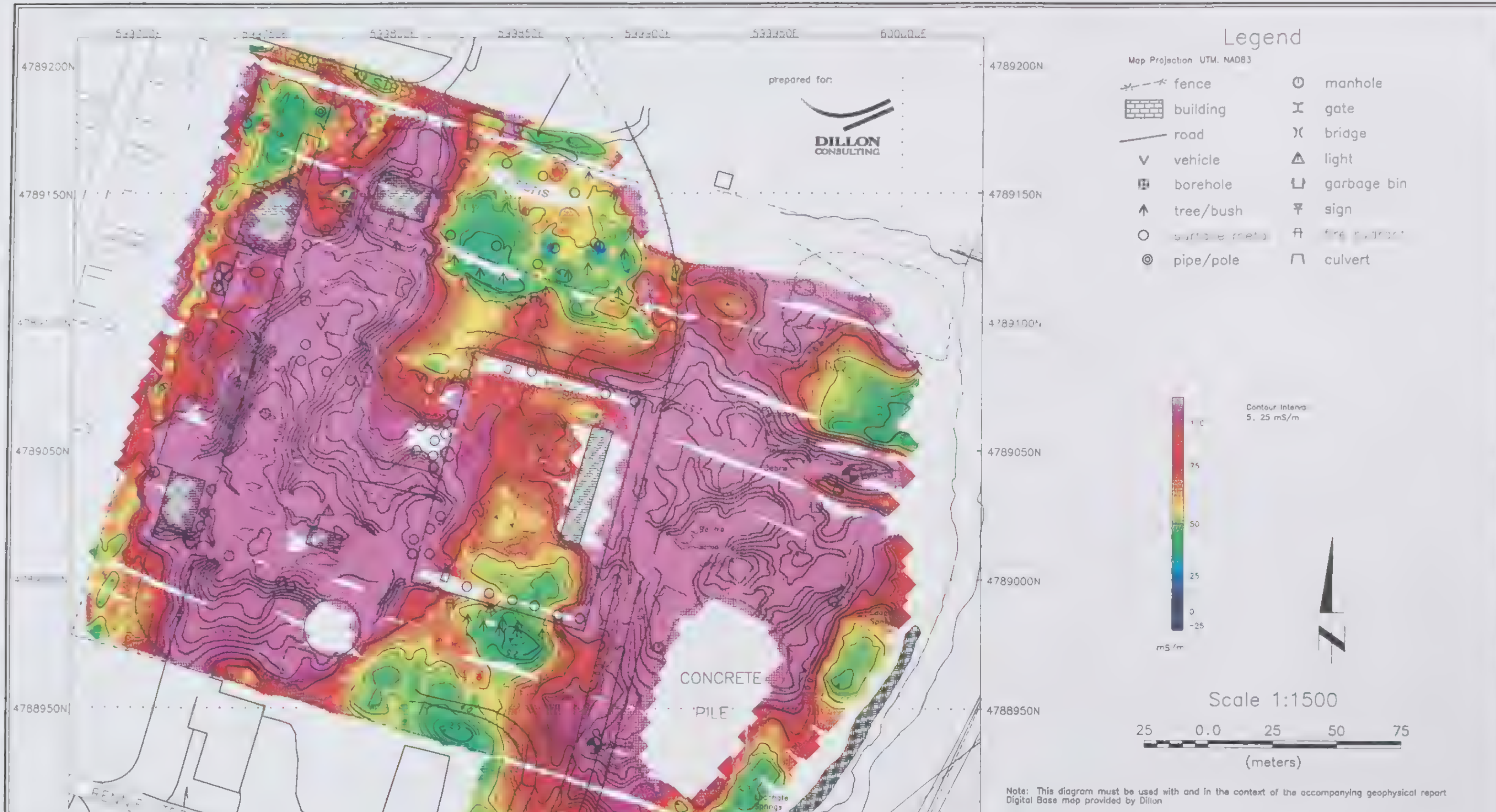


Note: This diagram must be used with and in the context of the accompanying geophysical report
Digital Base map provided by Dillon.
Map Projection: UTM: Zone 17, NAD83

Figure: 1
Survey Stations

Project: Proposed Red Hill Creek Expressway	
Location: Hamilton Public Works Yard, Hamilton, Ontario	
Client: Dillon Consulting Ltd.	
Survey Date: Oct. 6, 1998	Project No.: TK051
Instrument: EM31	

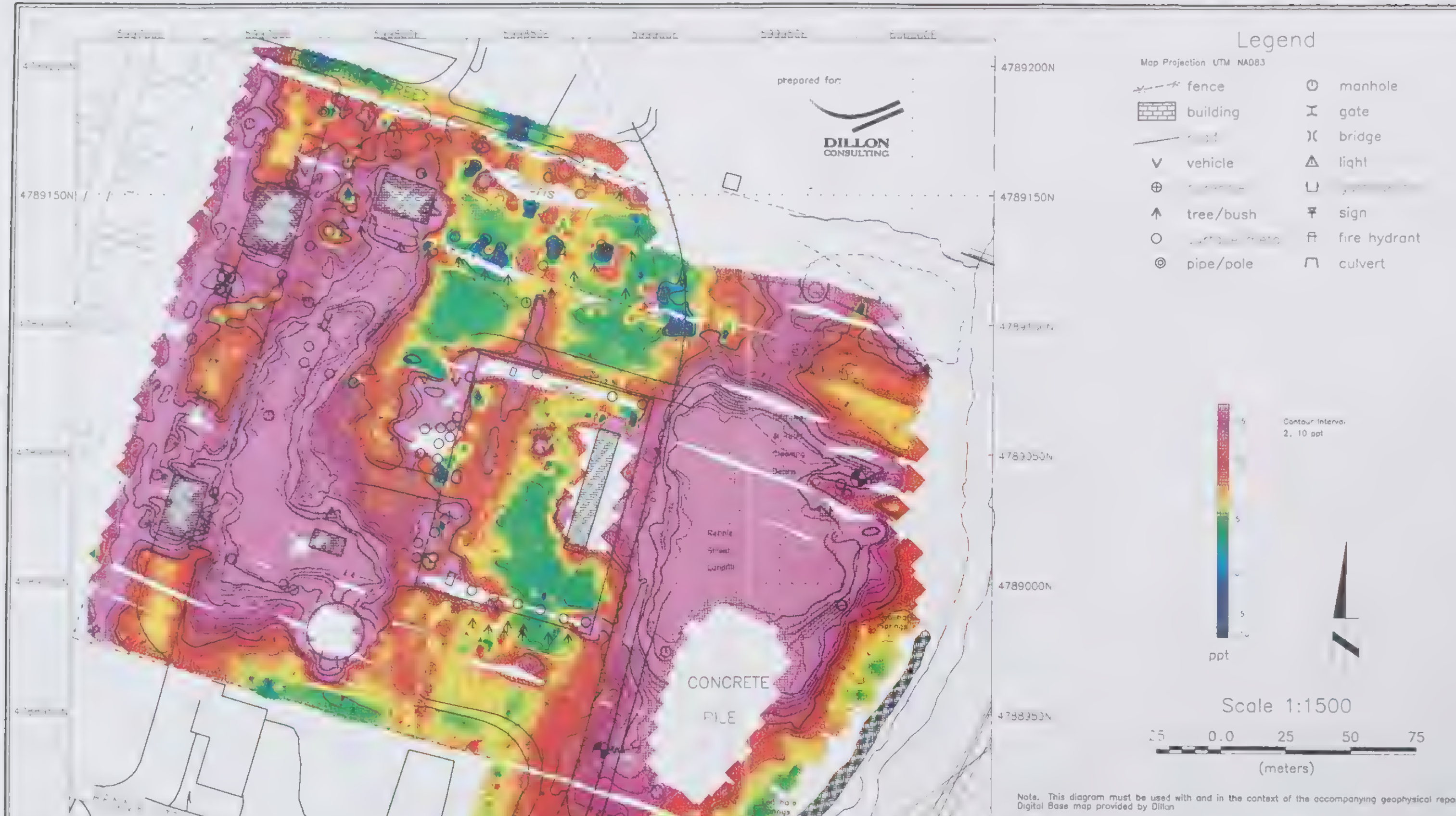
Hyd-Eng GEOPHYSICS INC.



Note: This diagram must be used with and in the context of the accompanying geophysical report
Digital Base map provided by Dillon

Figure: 2
Apparent Conductivity

Project: Red Hill Creek Expressway	
Location: Hamilton Public Works Yard, Hamilton, Ontario	
Client: Dillon Consulting Ltd.	Hyd-Eng GEOPHYSICS INC.
Survey Date: Oct. 6, 1998	Project No.: TK051
Instrument: EM31	



Note. This diagram must be used with and in the context of the accompanying geophysical report
Digital Base map provided by Dillon

Figure: 3
Inphase

Project: Red Hill Creek Expressway	
Location: Hamilton Public Works Yard, Hamilton, Ontario	
Client: Dillon Consulting Ltd.	
Survey Date: Oct. 6, 1998	Project No.: TK051
Instrument EM31	

Hyd-Eng GEOPHYSICS INC.

Legend

Map Projection UTM NAD83

	fence		manhole
	building		gate
	road		bridge
	vehicle		light
	borehole		garbage bin
	tree/bush		sign
	surface metal		fire hydrant
	pipe/pole		culvert

Sun Inclination: 35°
Sun Declination: 170°

Scale 1:1500

25 0.0 25 50 75

(meters)

Note: This diagram must be used with and in the context of the accompanying geophysical report Digital Base map provided by Dillon.

Figure: 4 Shaded Inphase Data	
Project: Red Hill Creek Expressway	
Location: Hamilton Public Works Yard, Hamilton, Ontario	
Client: Dillon Consulting Ltd.	
Survey Date: Oct. 6, 1998	Project No.: TK051
Instrument: EM31	

Hyd-Eng® GEOPHYSICS INC.

Figure: 5a
Interpretation Map

Project: Proposed Red Hill Creek Expressway
Location: Hamilton Public Works Yard, Hamilton, Ontario
Client: Dillon Consulting Ltd.
Survey Date: Oct. 6, 1998
Project No. TK051.
Instrument EM31

Hyd-Eng GEOPHYSICS INC.

599750E
599850E
599900E
599950E
600000E
4789200N
4789150N
4789100N
4789050N
4789000N
4788950N
4788900N
BRAMPTON STREET
RENNIE STREET
DILLON
CONSULTING
borehole
tree/bush
surface metal
pipe/pole
garbage bin
sign
fire hydrant
culvert
Anomalies:
Complex Zone
refer to text
Z1
Z2
EXISTING
MOUND
CONCRETE
PILE
Leachate
Springs
Garbage
Bins
Scale 1:1500
25 0.0 25 50 75
(meters)
Note: This diagram must be used with and in the context of the accompanying geophysical report
Digital Base map provided by Dillon
Map Projection: UTM Zone 17 NAD83
Figure: 5b
Interpretation Map
Project: Proposed Red Hill Creek Expressway
Location: Hamilton Public Works Yard, Hamilton, Ontario
Client: Dillon Consulting Ltd
Survey Date: Oct 6, 1998
Project No: TK051
Instrument: EM31
Hyd-Eng
GEOPHYSICS INC.

A report on an

EM31 Survey,

conducted about the southern portion of the

Hamilton Works Yard,

Hamilton, Ontario

Dillon Consulting Limited

April 13, 2000

Hyd-Eng Reference: 00-7447-0300

INTRODUCTION

Dillon Consulting Limited (Dillon) was contracted by the City of Hamilton to conduct a geophysical investigation about a former landfill ("Rennie Street Landfill") located at the active Hamilton works yard, Hamilton, Ontario. The investigation was specifically undertaken to identify anomalous geophysical data that may aid in identifying the lateral extent of landfilling within the survey area.

Initial work completed by Hyd-Eng Geophysics Incorporated (Hyd-Eng report TK051; October 1998) identified the approximate limits of the landfill about the original survey area. The most recent survey was initiated to geophysically survey the southern portion of the works yard not surveyed in 1998.

SCOPE OF WORK

An electromagnetic (EM31) geophysical survey was conducted about the southern portion of the Hamilton works yard, an area that is approximately 1.35 hectares in size.

The geophysical survey was primarily undertaken to delineate geophysical variations indicative of anomalous soil/porewater conditions and/or buried metal. These variations may then be related to the possible limits of the decommissioned landfill suspected to extend westward into the survey area.

PHYSICAL PROPERTIES

The measurement of variations in the physical properties of geological units is the basis of all geophysical surveys. One of the electrical properties of a material that can be measured is its electrical conductivity (milliSiemens/metre). In general, a saturated clay overburden will have an apparent conductivity (typically ranging from 30 to 60 mS/m). A clean sand, or compact sandy/silty till unit has a conductivity, ranging from 1 to 10 mS/m. Factors such as porewater conductivity, porosity, degree of saturation, compaction, and mineralogy, control the bulk material conductivity and can cause

variations beyond natural limits. "Leachate" from most landfills will tend to have a significantly higher electrical conductivity when compared to 'clean and natural' groundwater. Typically, the leachate will contain chloride ions and other dissolved species, which will increase the conductivity of the groundwater. Consequently, as leachate moves through the ground it tends to increase the naturally occurring bulk apparent conductivity of the subsurface. This conductivity contrast between material saturated with natural groundwater and that portion of the ground containing conductive leachate ('plume') allows the contaminant to be mapped by measuring the changing electrical properties (conductance) of the subsurface.

It should be noted that detection and/or recognition of geophysical anomalies indicative of 'landfilling' and/or conductive contaminant is highly site specific and is dependent on the number of factors. These factors include the concentration of the fill/contaminate; it's depth and thickness, native materials present, as well as local sources of EM or electrical interference ("noise").

If the subsurface is so conductive so as to cause instrument readings to increase above the levels expected from natural materials, designating an area as geophysically anomalous is relatively uncomplicated. However, in many cases the identification of subtle conductivity or inphase variations as anomalous can be difficult and depends heavily on pattern recognition. In the case of a conductive 'plume', the pattern would normally include a connection to the source, and a trend of decreasing conductivity values extending away from the source(s). However, the limits of the "anomalous" zone cannot be identified without first defining what is not anomalous (i.e. "background".) Often in the case of fill it is the irregularity of the response that is the indicative parameter rather than the absolute value.

Background apparent conductivity can vary considerably depending on geologic variations, and changes in the water table depth. For example, if water conductivity were uniform throughout the site, areas where the water table is shallow (ex. near surface water, or moist low lying ground, such as was noted throughout portions of the survey

area) will tend to have higher conductivity readings when compared to areas that are topographically elevated.

Defining “background” conditions would be complicated, and the pattern of leachate migration from the landfill more difficult to define, if porewater, which has not been influenced by the presence of the landfill, also had a variable conductivity.

It is unlikely that the limits of anomalous zones, as inferred from the geophysical data, will correlate exactly with ‘real’ limits of landfilling or contaminant migration based on accepted standards. The geophysical anomalies will however be relatively indicative of ‘significant landfilling’ increased porewater/soil conductivity and therefore the direction of possibly existing conductive leachate migration.

Many forms of groundwater contamination typical of landfill leachate are not electrically conductive and will not be mapped by geophysical techniques. Each of these contaminants will have its own plume of concentration depending on mobility, adsorption and a variety of other factors. Fortunately the “conductivity plume” is typically one of the most mobile of these plumes and therefore provides a conservative indication of contaminant migration.

EQUIPMENT AND THEORY

This survey was carried out with the GEONICS EM31. The EM31 instrument is a frequency domain electromagnetic device designed for measuring apparent conductivity and is also well suited for buried metal detection. The EM31 utilises the principle of electromagnetic (EM) induction to measure the electrical properties of the earth.

This instrument generates an electromagnetic (EM) field by passing a current through a transmitter coil. As the field passes through the ground it induces a small current flow within the ground. These ground currents create a secondary EM field in the ground. The receiver coil then measures the combined primary (produced by instrument) and

secondary EM field (produced by encompassing materials). The instrument then converts the EM field properties into quadrature (apparent conductivity) measurements of the subsurface in units of milliSiemens per metre (mS/m) and inphase measurements in parts per thousand (ppt). The value for the bulk apparent conductivity of the ground represents a roughly hemispherical volume of radius 5 to 6 metres centred at the operator. The inphase response is sensitive to metal and relatively insensitive to changes in the apparent conductivity of the ground. However, extremely high ground conductivity will affect the inphase values. The quadrature response is somewhat affected by metal.

Figure 1: EM31 with GPS backpack

For a complete description of the theory of operation and technical details of the EM31 refer to McNeill, 1980.[1]

FIELD PROCEDURES

The geophysical survey grid was established at the site (Figure 1) using a fence corner post, located at the base of Rennie Street, as a local Base line. Several Tie lines were also established parallel to the base line. These tie lines allowed the operator to

---

[1] McNeill, J.D. 1980, Electromagnetic Terrain Conductivity Measurements at Low Induction Numbers, Geonics Ltd., Note TN-6, 16pp.

maintain a consistent line direction and spacing, thereby ensuring adequate and proper data coverage.

Using the Base and Tie line markers as a guide, EM31 data were collected at approximately at a 0.75 metre station spacing along lines spaced approximately 5 meters apart.

DATA PROCESSING

Upon completion of each survey day, the EM31 were transferred from the data loggers to a portable computer.

These data were then sorted, gridded, contoured, and plotted at an appropriate scale using *Geosoft* software, a data presentation program developed by Geosoft Limited of Toronto, Ontario.

The results of the EM31 survey are displayed as colour, contoured plots of the apparent conductivity (Fig.2) and inphase (Fig.3) data. A consistent colour scheme was, used between all EM31 surveyed area, chosen so as to highlight variations in the data. The EM31 data are also displayed as colour, contoured plots of the apparent conductivity and inphase data. The data were coloured and contoured to represent the complete range of values. Background values are generally shown in yellow and green. Red and blue colours represent anomalous readings above and below background, respectively.

Interference from surface metal will affect the instruments' response to nearby subsurface anomalous features. When the extent of this interference is unknown, buried features located adjacent to or directly below the source of interference may go undetected.

RESULTS

Anomalous areas *not* attributed to cultural interference, or other explainable sources, are highlighted on the interpretation maps (Figure 4). Note that definitive background have not been established in the geophysical data. Although limited areas of relatively lower conductivity values are noted, these are dispersed between broad zones of extremely high conductivity and cannot be established as "natural". However, for interpretative purposes a background conductivity value of 35 to 45 mS/m has been estimated for the interpretation of the data. This background value is typical for a silt to silty clay material. Inphase background values range between 1 and 4 ppt across the site. Areas that have conductivity and inphase readings which deviate significantly from these background values are generally considered anomalous and are labeled on the interpretation figure with the letters "C" and "I" respectively.

A number of factors influence the size of an anomaly including depth of burial, type of fill (background values), cultural interference, and the instruments orientation relative to the object. The interpreted results of the geophysically surveyed area are discussed below. Due to the size and number of anomalous zones and features encountered, the anomalies are divided into groups based on similar response and characteristics.

C1 and ***C2*** designate broad regions of extremely elevated apparent conductivity (>75 mS/m) and inphase (> 15ppt) data. These anomalous regions are interpreted to result from anomalous soil/fill material; porewater conductivity; and possibly buried metallic objects of varying shape, size, and depth of burial.

C3 designates a broad region of slightly to moderately elevated apparent conductivity (50 to 75 mS/m) and inphase (5 to 15ppt) data. This anomalous zone surrounds the extremely elevated regions, **C1** and **C2**. This weaker zone is interpreted to most likely result from elevated porewater conductivity and anomalous soil/fill material. Buried metal may also exist beneath these zones, but to a lesser degree when compared to areas **C1** and **C2**.

L1 is a linear trend that appears in the inphase and/or apparent conductivity data. This elongated feature may result from a significant increase in fill associated with a suspected pipe transecting this general area.

L2 is a weak linear trend that primarily appears in the apparent conductivity data. This elongated feature likely results from a metal culvert exposed at either end.

As the primary objective of the geophysical survey was to delineate the most likely lateral extent of buried waste/fill indicative of former 'landfilling' the **C1** and **C2** (>75 mS/m) are considered a qualitative indicator. This interpreted limit of 'landfilling' is based on a comparison of the non-intrusive geophysical data interpretation, discussed above, to local intrusive test pit information provided by Dillon Consulting Limited in 1998.

The ***C1*** zone likely reflects the presence of a significant/thick component of waste material in the overburden, while the ***C2*** and **C3** zones likely reflect the presence of a minor/increasingly thinner component of waste material. It is also possible that the ***C3*** zone indicates an area where the waste material is predominantly inert, such as glass and paper, which would have little or no anomalous geophysical response. It is highly likely that conductive porewater is also contributing to all anomalous readings.

Since it is assumed that readings below 50 mS/m are considered "background", it is possible that these zones are in actuality slightly anomalous and that no true background values exist within the survey area.

LIMITATIONS OF REPORT

This report was prepared by Dillon Consulting Limited . The material in it reflects Dillon's best judgement in context of the information available to it at the time of preparation. This report is based on data and information collected during the investigation conducted by Dillon personnel and is based solely on the conditions of the property at the time of the site reconnaissance, as described in this report. No intrusive, or direct sampling was conducted as part of this survey.

Any use which a third party makes of this report, or any reliance on or decision to be made based on it, are the responsibilities of such third parties. Dillon accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

Dillon makes no warranty, expressed or implied, and assumes no liability with respect to the use of information contained within this report. No changes to the report form or content may be made without Dillon's written approval.

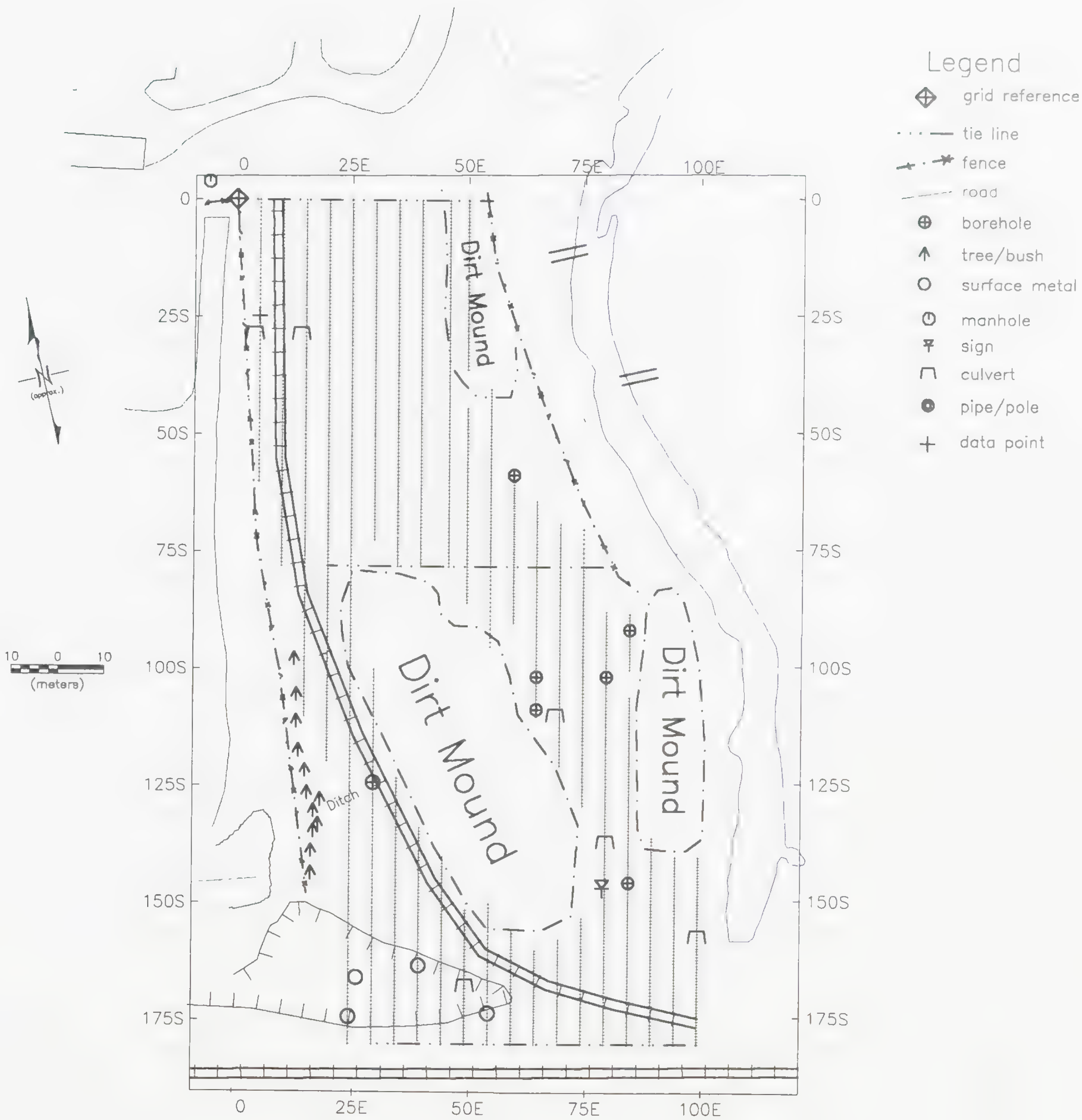


Figure: 1
Survey Stations

Project: Rennie Street Landfill - Southern area	
Location: Hamilton, Ontario	
Client: City of Hamilton	
Survey Date: March 26, 2000	Project No.: 00-7447-0300
Instrument: EM31	

DILLON CONSULTING

Note: This diagram must be used with and in the context of the accompanying geophysical report.

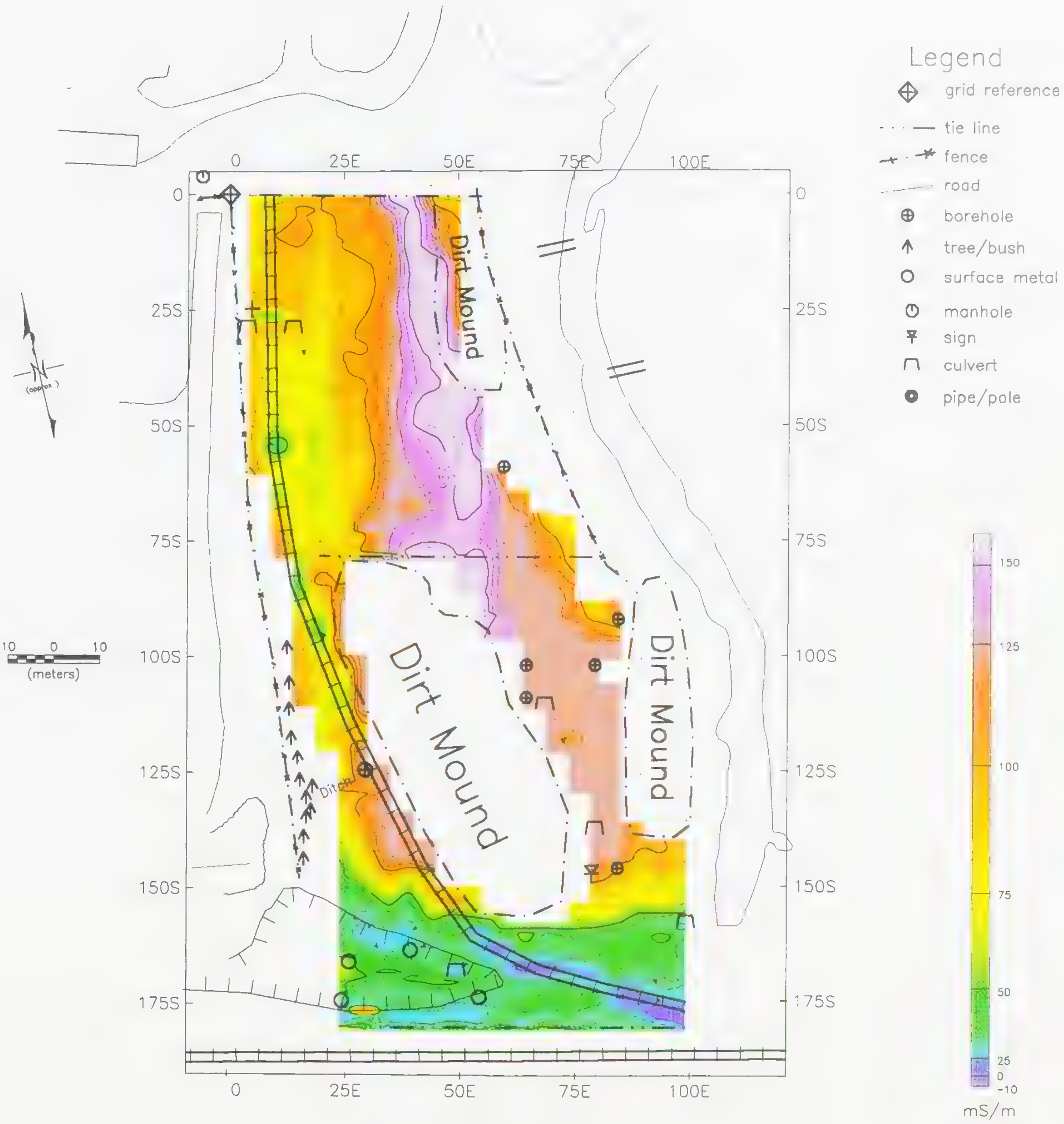


Figure: 2
Apparent Conductivity

Project: Rennie Street Landfill – Southern area	
Location: Hamilton, Ontario	
Client: City of Hamilton	
Survey Date: March 26, 2000	Project No.: 00-7447-0300
Instrument: EM31	

DILLON CONSULTING

Note: This diagram must be used with and in the context of the accompanying geophysical report.

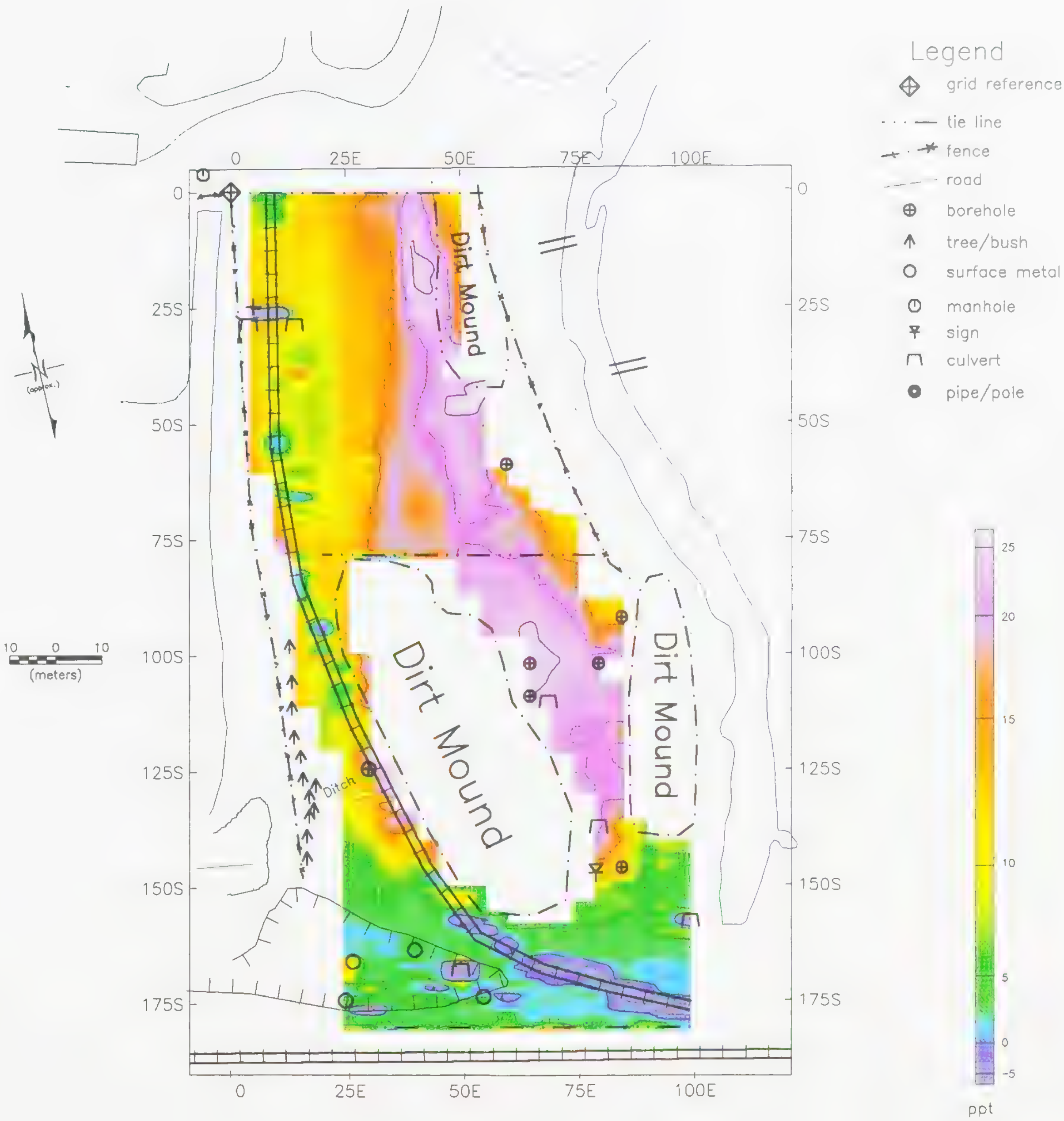


Figure: 3
Inphase

Project: Rennie Street Landfill – Southern area	
Location: Hamilton, Ontario	
Client: City of Hamilton	
Survey Date: March 26, 2000	Project No.: 00-7447-0300
Instrument: EM31	

DILLON CONSULTING

Note: This diagram must be used with and in the context of the accompanying geophysical report.

Figure: 4
Interpretation Map

Project:	Rennie Street Landfill – Southern area
Location:	Hamilton, Ontario
Client:	City of Hamilton
Survey Date: March 26, 2000	Project No.: 00-7447-0300
Instrument: EM31	

DILLON CONSULTING

Note: This diagram must be used with and in the context of the accompanying geophysical report.

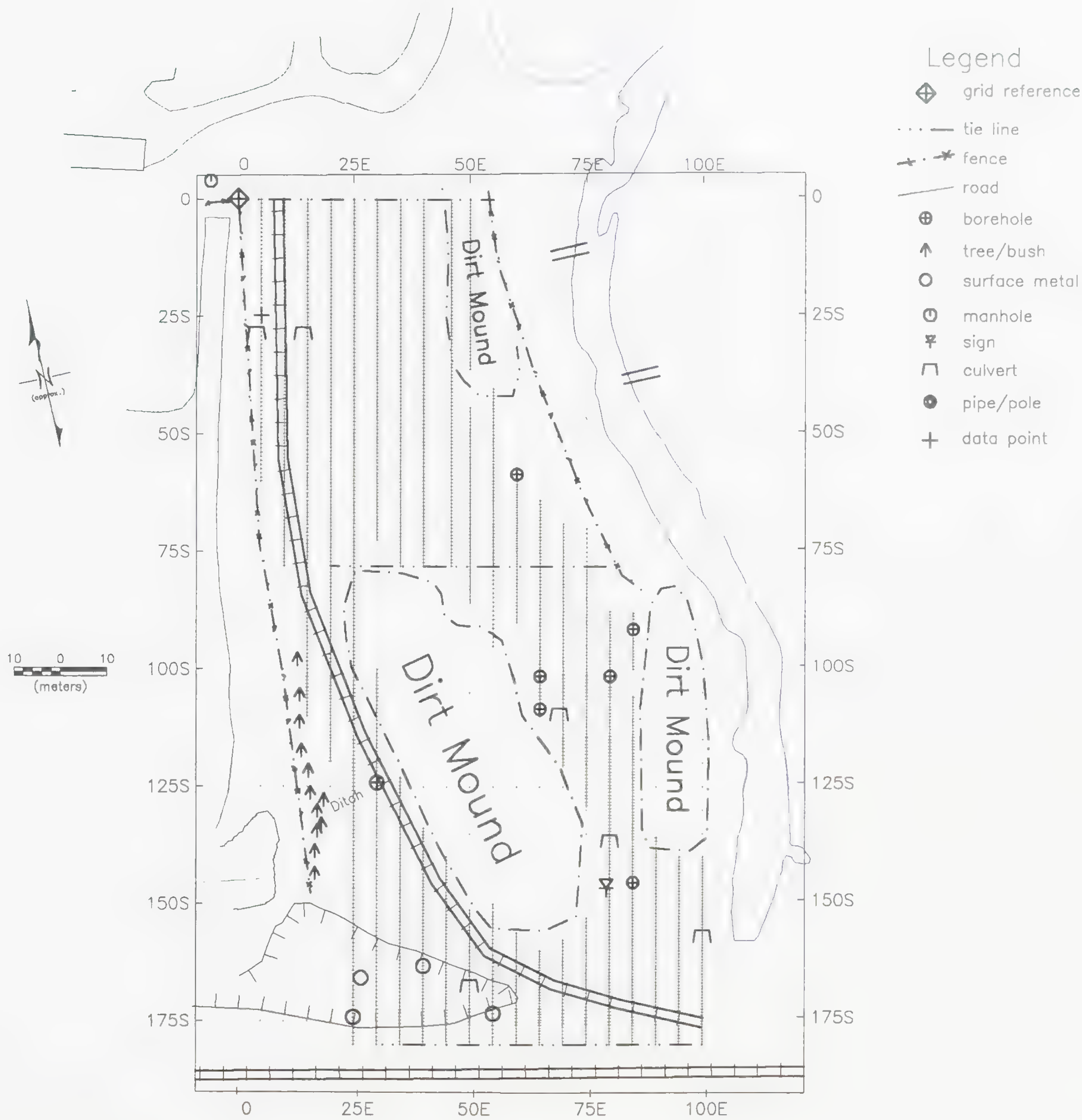


Figure: 1
Survey Stations

Project:	Rennie Street Landfill – Southern area
Location:	Hamilton, Ontario
Client:	City of Hamilton
Survey Date:	March 26, 2000
Project No.:	00-7447-0300
Instrument:	EM31

DILLON CONSULTING

Note: This diagram must be used with and in the context of the accompanying geophysical report.

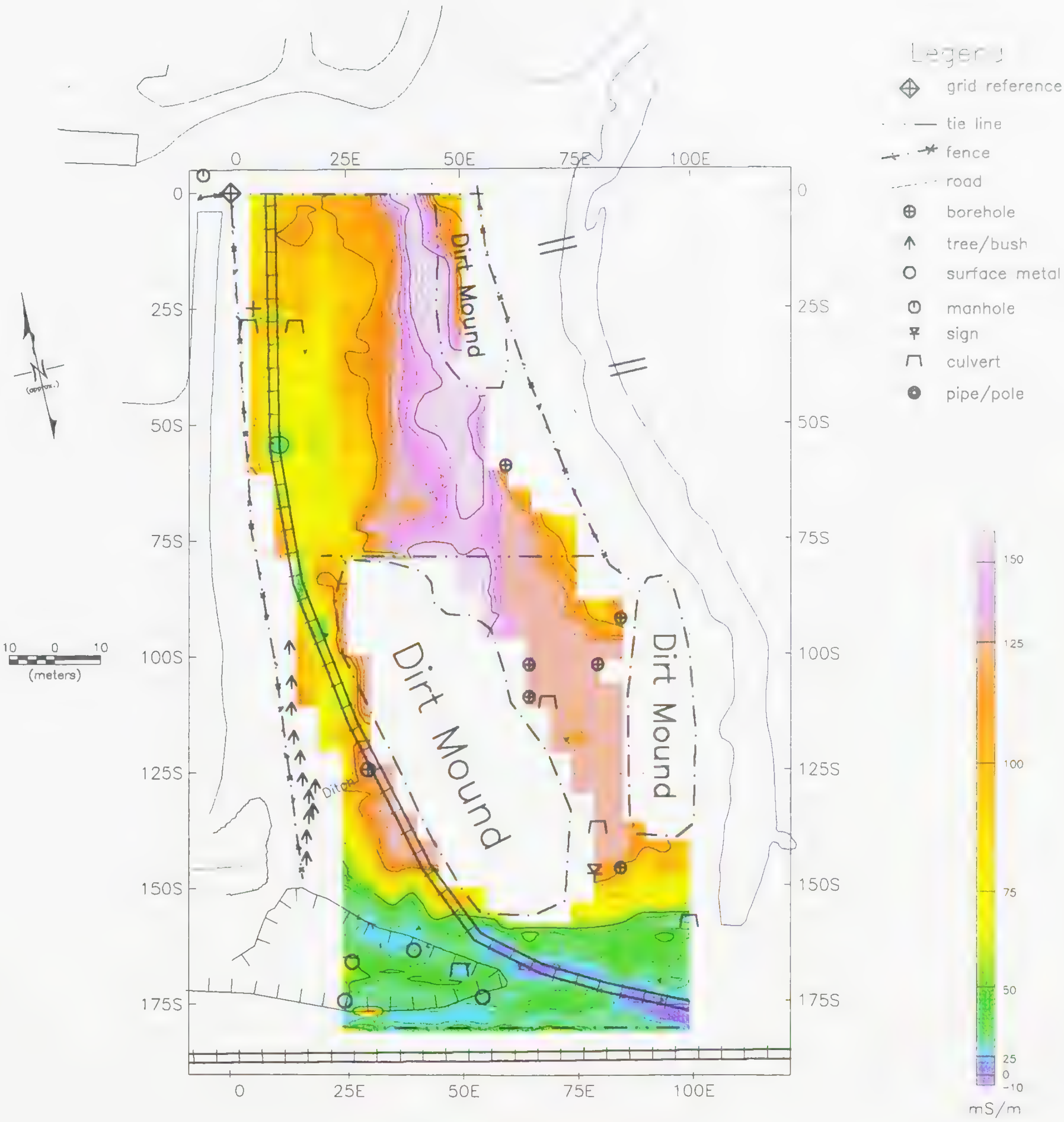


Figure: 2
Apparent Conductivity

Project: Rennie Street Landfill – Southern area	
Location: Hamilton, Ontario	
Client: City of Hamilton	DILLON CONSULTING
Survey Date: March 26, 2000	Project No.: 00-7447-0300
Instrument: EM31	

Note: This diagram must be used with and in the context of the accompanying geophysical report.

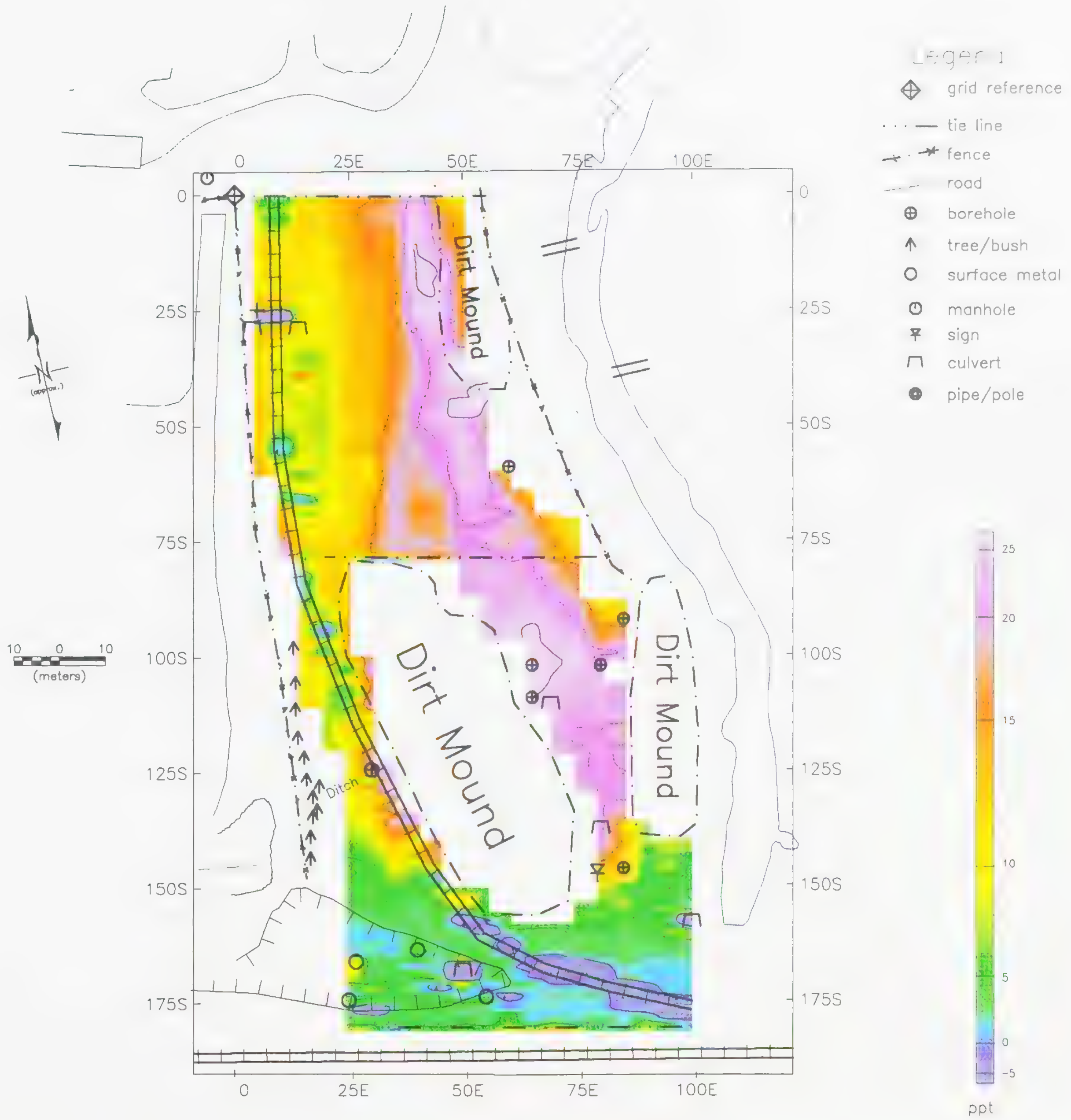


Figure: 3
Inphase

Project: Rennie Street Landfill – Southern area	
Location: Hamilton, Ontario	
Client: City of Hamilton	DILLON CONSULTING
Survey Date: March 26, 2000	Project No.: 00-7447-0300
Instrument: EM31	

Note: This diagram must be used with and in the context of the accompanying geophysical report.

Note: This diagram must be used with and in the context of the accompanying geophysical report.

Figure: 4
Interpretation Map

Project: Rennie Street Landfill – Southern area

Location: Hamilton, Ontario

Client: City of Hamilton

Survey Date: March 26, 2000 | Project No.: 00-7447-0300

Instrument: EM31

DILLON CONSULTING

APPENDIX E

Summary of Chemical Analytical Data

List of Chemistry Tables

Table E-1	Native Soil Analytical Results - Metals and General Chemistry Parameters
Table E-2	Native Soil Analytical Results - Polycyclic Aromatic Hydrocarbons (PAHs)
Table E-3	Native Soil Analytical Results - Volatile Organic Chemicals (VOCs) and Total Petroleum Hydrocarbons (TPH)
Table E-4	Native Soil Analytical Results - Polychlorinated Biphenyls (PCBs)
Table E-5	Fill and Waste Analytical Results - Metals and General Parameters
Table E-6	Fill and Waste Analytical Results - PAHs
Table E-7	Fill and Waste Analytical Results - VOCs and TPH
Table E-8	Waste Analytical Results - PCBs
Table E-9	Waste Analytical Results - Regulation 347 Leachate Extraction Analysis
Table E-10	Leachate Analytical Results - General Chemistry and Metals
Table E-11	Leachate Analytical Results - VOCs and TPH
Table E-12	Leachate Analytical Results - PCBs
Table E-13	Leachate Analytical Results - PAHs
Table E-14	Surface Water Analytical Results - Metals and General Chemistry
Table E-15	Surface Water Analytical Results - VOCs, PCBs and TPH
Table E-16	Surface Water Analytical Results - PAHs
Table E-17	Creek Bank Soil Analytical Results - VOCs (BTEX), TPH and PCBs

TABLE E-1
RENNIE STREET LANDFILL
NATIVE SOIL ANALYTICAL RESULTS
METALS AND GENERAL CHEMISTRY PARAMETERS

Parameter	*1 MOE Table B Criteria	Units	MW6-11	MW6-13	MW6-60	MW6-63	MW6-64
		Sample Depth (m)	10.7 - 11.1	12.2 - 13.1m	1.52 - 2.13	0.1 - 0.61	0.1 - 0.76
		Matrix	Soil	Soil	Soil	Soil	Soil
General Chemistry Parameters							
Cyanide	100	mg/kg	-	-	-	-	-
Nitrogen T. Kjeldahl as N	nv	mg/kg	-	-	300	2900	770
Nitrogen Total (%)	nv	%	0.046	0.049	-	-	-
pH	nv	pH units	6.91	6.76	8.11	7.13	7.31
Conductivity (mS/cm)	1.4	mS/cm	0.21	0.15	0.379	0.187	0.163
SAR	12		0.31	0.25	2.75	0.11	1.13
Total Phenolics	40	mg/kg	-	-	<0.05	<0.05	<0.05
Solids Total	nv	%	-	-	83	79.4	83.9
Ammonia as N	nv	mg/kg	-	-	1	<1	<1
Metals							
Antimony	40	ug/g	0.5	0.6	0.5	1.2	< 0.5
Arsenic	40	ug/g	0.9	0.6	4.1	5.3	3
Barium	1500	ug/g	57.9	49.2	174	110	81
Beryllium	1.2	ug/g	<0.5	<0.5	1	1	1
Boron (Available)	2	ug/g	0.5	0.5	0.2	0.3	0.3
Cadmium	12	ug/g	0.7	<0.5	< 1	1	1
Chromium	750	ug/g	26.4	23.4	23	25	21
Chromium (VI)	8	ug/g	<0.5	<0.5	-	-	-
Cobalt	80	ug/g	6.4	5.1	14	10	13
Copper	225	ug/g	24.1	16.9	9	62	10
Lead	1000	ug/g	28.4	14.4	25	63	11
Mercury	10	ug/g	<0.5	<0.5	0.09	0.22	0.04
Molybdenum	40	ug/g	0.6	-	< 2	< 2	< 2
Phosphorous	nv	ug/g	-	-	-	772	632
Nickel	150	ug/g	10.7	4.9	31	24	29
Selenium	10	ug/g	0.5	0.6	< 0.5	0.8	< 0.5
Silver	40	ug/g	<0.5	<0.5	< 1	< 1	< 1
Thallium	32	ug/g	-	-	0.1	< 1	< 1
Vanadium	200	ug/g	24.1	21.8	29	30	28
Zinc	600	ug/g	166.1	98.2	102	1050	76

*1 Ministry of Environment, Guideline For Use At Contaminated Sites in Ontario, Feb, 1997; Surface soil criteria for industrial/commercial land use for a non-potable groundwater condition, criteria for coarse grain soil.
"nv" = no value in Guideline
"-" = sample not analyzed

TABLE E-2
RENNIE STREET LANDFILL
NATIVE SOIL ANALYTICAL RESULTS
POLYCYCLIC AROMATIC HYDROCARBONS (PAHs)

Parameter	Units	*1 MOE Table B Criteria	Sample Location and Depth	
			MW6-11 10.7 - 11.1	MW6-13 12.2 - 13.1m
Acenaphthene	ug/g	1300	<0.02	<0.02
Acenaphthylene	ug/g	840	0.02	0.03
Anthracene	ug/g	28	<0.02	<0.02
Benzo[a]anthracene	ug/g	40	<0.003	<0.003
Benzo[b]fluoranthene	ug/g	19	<0.004	0.005
Benzo[k]fluoranthene	ug/g	19	<0.004	<0.004
Benzo[ghi]perylene	ug/g	40	<0.015	<0.015
Benzo[a]pyrene	ug/g	1.9	0.005	0.005
Chrysene	ug/g	19	0.04	0.02
Dibenzo[a,h]anthracene	ug/g	1.9	<0.01	<0.01
Fluoranthene	ug/g	40	0.03	0.04
Fluorene	ug/g	350	<0.02	<0.02
Indeno[1,2,3-c,d]pyrene	ug/g	19	<0.015	<0.015
Naphthalene	ug/g	40	0.04	0.02
Phenanthrene	ug/g	40	0.02	0.04
Pyrene	ug/g	250	0.02	0.03

*1 Ministry of Environment, Guideline For Use At Contaminated Sites in Ontario, Feb, 1997; Surface soil criteria for industrial/commercial land use for a non-potable groundwater condition, criteria for coarse grain soil.

TABLE E-3
RENNIE STREET LANDFILL
NATIVE SOIL CHEMICAL ANALYTICAL RESULTS
VOLATILE ORGANIC COMPOUNDS (VOCs) AND TOTAL PETROLEUM HYDROCARBONS (TPH)

Compound		Sample Designation	MW6-60 SS3	MW6-63 SS1	MW6-64 SS1
		Sample Depth (m)	1.5 - 2.13	0.1 - 0.61	0.1 - 0.76
		Matrix	Soil	Soil	Soil
	MOE Table B Soil Criteria *1	Units			
VOCs					
Chloromethane	nv	ug/kg	< 10	< 10	< 10
Vinyl Chloride	3	ug/kg	< 3	< 3	< 3
Bromomethane	61	ug/kg	< 10	< 10	< 10
Chloroethane	nv	ug/kg	< 10	< 10	< 10
Trichlorofluoromethane	nv	ug/kg	< 10	< 10	< 10
Acetone	3800	ug/kg	< 200	< 200	< 200
1,1-Dichloroethylene	2.4	ug/kg	< 2	< 2	< 2
Dichloromethane	140	ug/kg	< 20	20	20
t-1,2-Dichloroethylene	4100	ug/kg	< 5	< 5	< 5
Methyl-t-butylether(MTBE)	120000	ug/kg	< 10	< 10	< 10
1,1-Dichloroethane	22000	ug/kg	< 5	< 5	< 5
Methyl Ethyl Ketone	38000	ug/kg	< 20	< 20	< 20
Cis-1,2-Dichloroethylene	2300	ug/kg	9	< 5	< 5
Chlorobromomethane	nv	ug/kg	< 5	< 5	< 5
Chloroform	790	ug/kg	< 5	< 5	< 5
1,2-Dichloroethane	22	ug/kg	< 5	< 5	< 5
1,1,1-Trichloroethane	26000	ug/kg	< 5	< 5	< 5
Carbon Tetrachloride	100	ug/kg	< 5	< 5	< 5
Benzene	5300	ug/kg	< 5	< 5	< 5
1,2-Dichloropropane	19	ug/kg	< 5	< 5	< 5
Trichloroethylene	1100	ug/kg	10	< 5	< 5
Bromodichloromethane	25000	ug/kg	< 5	< 5	< 5
Cis-1,3-Dichloropropene	6.6(Total)	ug/kg	< 5	< 5	< 5
Methylisobutylketone	58000	ug/kg	< 20	< 20	< 20
t-1,3-Dichloropropene	6.6(Total)	ug/kg	< 5	< 5	< 5
1,1,2-Trichloroethane	3100	ug/kg	< 5	< 5	< 5
Toluene	34000	ug/kg	< 5	< 5	< 5
2-Hexanone	nv	ug/kg	< 20	< 20	< 20
Chlorodibromomethane	18000	ug/kg	< 5	< 5	< 5
1,2-Dibromoethane	nv	ug/kg	< 5	< 5	< 5
Tetrachloroethylene	450	ug/kg	< 5	< 5	< 5
1,1,2,2-Tetrachloroethane	37	ug/kg	< 5	< 5	< 5
Chlorobenzene	8000	ug/kg	< 5	< 5	< 5
Ethylbenzene	290000	ug/kg	< 5	< 5	< 5
m&p-Xylenes	34000(Total)	ug/kg	< 5	< 5	< 5
Bromoform	2300	ug/kg	< 5	< 5	< 5
Styrene	1200	ug/kg	< 5	< 5	< 5
o-Xylene	34000(Total)	ug/kg	< 5	< 5	< 5
1,3-Dichlorobenzene	30000	ug/kg	< 5	< 5	< 5
1,4-Dichlorobenzene	30000	ug/kg	< 5	< 5	< 5
1,2-Dichlorobenzene	30000	ug/kg	< 5	< 5	< 5
Total Xylenes Calculated	34000	ug/kg	< 5	< 5	< 5
1,1,1,2 Tetrachloroethane	19	ug/kg	< 5	< 5	< 5
Total Petroleum Hydrocarbons					
TPH C6 -C10	1000(Total)	mg/kg	0.14	<0.1	<0.1
TPH C10 - C24	1000(Total)	mg/kg	<40	<40	<40
TPH (Heavy Oil)	5000	mg/kg	<100	418	<100

NOTES: "-" = not analysed, nv = no value

*1 = Ministry of the Environment, Guideline for Use at Contaminated Sites in Ontario, Feb 1997; Surface soil criteria for Industrial/ commercial land use for a non-potable groundwater condition, Criteria for course grained soil

TABLE E-4
RENNIE STREET LANDFILL
NATIVE SOIL ANALYTICAL RESULTS
POLYCHLORINATED BIPHENYLS (PCBs)

Parameter	*1 MOE Table B Criteria	Units	Sample Location and Depth (m)							
			BH6-15 12.2-12.8 m	BH6-16 12.2-12.8 m	BH6-17 10.7-11.3m	BH6-18 10.8-11.8m	BH6-19 10.7-11.1m	MW6-60 1.5 - 2.13m	MW6-63 0.1 - 0.61m	MW6-64 0.1 - 0.76m
PCBs	25	ug/g	0.86	0.58	1.46	7.48	0.62	<0.005	0.12	0.007

*1 Ministry of Environment, Guideline For Use At Contaminated Sites in Ontario, Feb, 1997; Surface soil criteria for industrial/commercial land use for a non-potable groundwater condition, criteria for coarse grain soil.

TABLE E-5
RENNIE STREET LANDFILL
WASTE ANALYTICAL RESULTS
METALS AND GENERAL PARAMETERS

			Monitoring Wells									Test Pits								
	Sample ID		MW6-11	MW6-12	MW6-13	MW6-14	MW6-59	MW6-59	MW6-61	BH6-62	MW6-65	TP28-9.5'	TP27-4'	TP31-5'	TP33-5'	TP3"B-5'	TP32 2-3'	TP35 7'	TP36 9'	TP34 7'
	Sample Depth (m)		3 0 - 6 5	3 0 - 6 5	3.0 - 6.5	7.6 - 9 8	1.52 - 2.13	3.81 - 4.4	3.81 - 4.4	0.76 - 1.37	0.1 - 0.76	2.89	1.22	1 52	1 52	1 52	0 76	2 1	2 7	2 1
	Matrix		Waste	Waste	Waste	Waste	Waste	Waste	Waste	Fill	Fill	Waste	Waste	Waste	Waste	Waste	Fill	Fill	Waste	Fill
Parameter	*1 MOE Table B Criteria	Units																		
GENERAL PARAMETERS																				
Cyanide	100	mg/kg	-	-	-	-	0 1	-	-	-	-	<0 1	<0 1	<0 1	<0 1	<) 1	-	-	-	-
Nitrogen T Kjeldahl as N	n/v	mg/kg	-	-	-	-	820	710	460	540	1100	700	2000	1600	2200	520	1000	730	3400	2300
Nitrogen Total (%)	n/v	%	0 042	0 038	0 049	0 035	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH	n/v	pH units	7 19	7 08	7 1	7 19	8	7 27	7 49	8 07	7 89	7 4	7 6	8	7 4	8	7 71	8 03	7	7 94
Conductivity (mS/cm)	1 4	mS/cm	0 17	0 24	0 19	0 26	4 82	10 2	1 96	2 22	0 379	0 558	0 98	2 38	24 5	0 83	0 705	0 894	4 78	1 02
SAR (*2)	12		0 28	0 36	0 45	0 34	29 6	11 6	1 61	0 05	0 11	0 73	0 35	19 4	132	1 36	0 09	5 04	12 7	6 67
Total Phenolics	40	mg/kg	-	-	-	-	0 16	<0 05	<0 05	0 11	0 41	0 08	7 24	0 09	0 28	<0 05	<0 05	<0 05	0 11	<0 05
Solids Total	n/v	%	-	-	-	-	53 2	73 5	70 9	84 1	88 1	61 6	56 7	56 5	45 1	8' 1	82 8	79 8	50	72 5
Ammonia as N	n/v	mg/kg	-	-	-	-	23	19	3	<1	<1	9	12	48	34	5	<1	<1	11	<1
METALS																				
Antimony	40	mg/kg	0 5	0 8	0 5	< 0 5	0 6	0 5	0 6	0 6	< 0 5	4	1 4	1 2	0 9	<0 5	< 0 5	< 0 5	0 9	0 6
Arsenic	40	mg/kg	0 6	0 5	0 7	0 8	3	2 2	5 9	3 3	4 8	6 7	2 6	1 1	0 9	1 9	3 5	4 9	9 4	7 8
Barium	1500	mg/kg	87 1	263 7	870 7	215 3	64	128	672	1250	91	180	258	216	166	109	80	114	153	109
Beryllium	1 2	mg.kg	<0 5	<0 5	<0 5	<0 5	1	1	1	1	1	1	< 1	1	1	1	1	1	1	1
Boron (Available)	2	mg/kg	0 7	0 5	0 8	0 6	0 8	1 9	2 5	1 7	0 4	0 7	0 4	1 4	3 4	8	0 2	0 4	1 4	0 3
Cadmium	12	mg/kg	0 8	4 1	2 4	3 8	1	1	< 1	< 1	1	3	3	3	2	1	1	1	5	2
Chromium	750	mg/kg	41 4	44 4	81 4	72 3	23	25	24	99	22	41	21	34	31	1'	21	23	38	29
Chromium (VI)	8	mg/kg	<0 5	<0 5	<0 5	<0 5	-	-	-	-	-	< 0 3	< 0 3	< 0 3	< 0 3	<0 3	-	-	-	-
Cobalt	80	mg.kg	6 2	10 3	9 4	8 3	15	13	15	13	12	9	5	10	9	[illegible]	13	13	14	16
Copper	225	mg/kg	89 6	126 7	149	173 7	17	15	54	82400	30	221	182	140	128	52	22	24	139	39
Lead	1000	mg kg	156 7	864 7	635 6	380	32	25	9390	28400	74	301	704	116	100	104	27	29	229	74
Mercury	10	mg/kg	<0 5	<0 5	<0 5	<0 5	0 07	0 09	0 29	0 1	0 06	1 25	0 37	0 54	0 73	0 28	0 1	0 28	1 11	0 25
Molybdenum	40	mg/kg	0 5	0 8	0 9	0 5	2	3	< 2	< 2	< 2	7	7	2	2	<2	2	3	4	2
Nickel	150	mg.kg	11 4	20 7	18 4	25 2	32	29	30	22	21	41	38	32	29	18	27	29	42	39
Selenium	10	mg/kg	0 5	0 7	0 5	0 6	< 0 5	< 0 5	< 0 5	< 0 5	0 8	10 6	3 5	1 6	0 6	<0 5	0 5	< 0 5	1 2	0 5
Silver	40	mg kg	<0 5	<0 5	<0 5	<0 5	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	<1	< 1	< 1	< 1	< 1
Thallium	32	mg.kg	-	-	-	-	0 1	0 1	0 3	0 2	< 1	< 1	< 1	< 1	< 1	0 2	< 1	< 1	< 1	< 1
Total Phosphorus	n/v	mg/kg	-	-	-	-	648	821	594	359	824	1040	305	1070	1170	4[illegible]2	685	601	780	966
Vanadium	200	mg/kg	20 6	18 3	22 6	20 9	31	34	43	17	32	20	12	27	27	2'	28	32	29	33
Zinc	600	mg.kg	389 2	575 5	803 8	775 1	78	99	198	4840	179	570	7560	1560	987	151	153	1450	342	668

"n/v" = no value in Guideline
"-" = sample not analyzed
*1 Ministry of Environment, Guideline For Use At Contaminated Sites in Ontario, Feb, 1997, Surface soil criteria for industrial/commercial land use for a non-potable groundwater condition, criteria for coarse grain soil
*2 SAR = Sodium Adsorption Ratio

TABLE E-6
RENNIE STREET LANDFILL
WASTE ANALYTICAL RESULTS
POLYCYCLIC AROMATIC HYDROCARBONS (PAHs)

Parameter	*1 MOE Table B Criteria	Sample Location and Depth					
		MW6-11 3.0 - 6.5m ug/g	MW6-12 3.0 - 6.5m ug/g	MW6-13 3.0 - 6.5m ug/g	MW6-14 7.6 - 9.8m ug/g	MW6-59 1.52 - 2.13m ug/g	TP36 9' 2.7m ug/g
Acenaphthene	1300	<0.02	<0.02	<0.02	<0.02	<2.50	<2.50
Acenaphthylene	840	0.05	0.02	0.02	0.04	<2.50	<2.50
Anthracene	28	<0.02	<0.02	<0.02	<0.02	<2.50	<2.50
Benzo[a]anthracene	40	<0.003	<0.003	<0.003	<0.003	<2.50	<2.50
Benzo[b]fluoranthene	19	0.005	<0.004	0.004	<0.004	<2.50	<2.50
Benzo[k]fluoranthene	19	<0.004	<0.004	<0.004	<0.004	<2.50	<2.50
Benzo[ghi]perylene	40	<0.015	<0.015	<0.015	<0.015	<2.50	<2.50
Benzo[a]pyrene	1.9	0.006	0.005	<0.005	<0.005	<2.50	<2.50
Chrysene	19	0.02	0.02	0.03	0.02	<2.50	<2.50
Dibenzo[a,h]anthracene	1.9	<0.01	<0.01	<0.01	<0.01	<2.50	<2.50
Fluoranthene	40	0.04	0.03	0.05	0.03	2.09	2.78
Fluorene	350	<0.02	<0.02	<0.02	<0.02	<2.50	<2.50
Indeno[1,2,3-c,d]pyrene	19	<0.015	<0.015	<0.015	<0.015	<2.50	<2.50
Naphthalene	40	0.02	0.02	0.03	0.02	<2.50	<2.50
Phenanthrene	40	0.02	0.03	0.02	0.03	1.51	<2.50
Pyrene	250	0.02	0.04	0.04	0.02	2.55	2.66
2-Methylnaphthalene	280(Total)	-	-	-	-	<2.50	<2.50
1-Methylnaphthalene	280(Total)	-	-	-	-	<2.50	<2.50

*1 Ministry of Environment, Guideline For Use At Contaminated Sites in Ontario, Feb, 1997; Surface soil criteria for industrial/commercial land use for a non-potable groundwater condition, criteria for coarse grain soil.
"n/v" = no value in Guideline
"-" = sample not analyzed

TABLE E-7
RENNIE STREET LANDFILL
WASTE SOIL ANALYTICAL RESULTS
VOLATILE ORGANIC COMPOUNDS (VOCs) AND TOTAL PETROLEUM HYDROCARBONS (TPH)

Parameter			Monitoring Wells/Boreholes					Test Pits								
	Sample Designation		MW6-59 SS3	MW6-59 SS6	MW8-61 SS6	BH6-62 SS2	MW6-65	TP27-4'	TP28-9.5'	TP31-5'	TP32 2-3'	TP33-5'	TP34 7'	TP35 7	TP36 9'	TP37B-5
	Sample Depth (m)		1.52 - 2.13	3.81 - 4.42	3.81 - 4.42	0.76 - 1.37	0.1 - 0.76	1.21	2.89	1.52	0.6 - 0.91	2.89	2.13	2.13	2.74	1.52
		Matrix	Waste	Waste	Waste	Fill	Fill	Waste	Waste	Waste	Fill	Waste	Fill	Fill	Waste	Fill
	MOE Table B Soil Criteria *1	Units														
VOCs																
Chloromethane	nv	ug/kg	< 13	< 10	< 10	< 10	< 10	< 12	< 12	< 13	< 10	< 16	< 10	< 10	< 14	< 10
Vinyl Chloride	3	ug/kg	< 4	< 3	< 3	< 3	< 3	< 4	< 4	< 4	< 3	< 5	< 3	< 3	< 4	< 3
Bromomethane	61	ug/kg	< 13	< 10	< 10	< 10	< 10	< 12	< 12	< 13	< 10	< 16	< 10	< 10	< 14	< 10
Chloroethane	nv	ug/kg	< 13	< 10	< 10	< 10	< 10	< 12	< 12	< 13	< 10	< 16	< 10	< 10	< 14	< 10
Trichlorofluoromethane	nv	ug/kg	< 13	< 10	< 10	< 10	< 10	< 12	< 12	< 13	< 10	< 16	< 10	< 10	< 14	< 10
Acetone	3800	ug/kg	< 260	< 200	< 200	< 200	< 200	< 240	< 240	< 260	< 200	< 320	< 200	< 200	< 280	< 200
1,1-Dichloroethylene	2.4	ug/kg	< 3	< 2	< 2	< 2	< 2	< 2	< 2	< 3	< 2	< 3	< 2	< 2	< 3	< 2
Dichloromethane	140	ug/kg	< 26	< 20	< 20	< 20	25	< 24	< 24	< 26	< 20	< 32	< 20	< 20	31	< 20
t-1,2-Dichloroethylene	4100	ug/kg	< 6	< 5	< 5	< 5	< 5	< 6	< 6	< 6	< 5	< 8	< 5	< 5	< 7	< 5
Methyl-t-butylether(MTBE)	120000	ug/kg	< 13	< 10	< 10	< 10	< 10	< 12	< 12	< 13	< 10	< 16	< 10	< 10	< 14	< 10
1,1-Dichloroethane	22000	ug/kg	< 6	< 5	< 5	< 5	< 5	< 6	< 6	< 6	< 5	< 8	< 5	< 5	< 7	< 5
Methyl Ethyl Ketone	38000	ug/kg	< 26	< 20	< 20	< 20	< 20	< 24	33	54	< 20	64	< 20	100	45	< 20
Cis-1,2-Dichloroethylene	2300	ug/kg	< 6	< 5	< 5	< 5	< 5	< 6	< 6	< 6	< 5	< 8	< 5	< 5	< 7	< 5
Chlorobromomethane	nv	ug/kg	< 6	< 5	< 5	< 5	< 5	< 6	< 6	< 6	< 5	< 8	< 5	< 5	< 7	< 5
Chloroform	790	ug/kg	< 6	< 5	< 5	< 5	< 5	< 6	< 6	< 6	< 5	< 8	< 5	< 5	< 7	< 5
1,2-Dichloroethane	22	ug/kg	< 6	7	< 5	< 5	< 5	< 6	< 6	< 6	< 5	< 8	< 5	< 5	< 7	< 5
1,1,1-Trichloroethane	26000	ug/kg	< 6	< 5	< 5	3100	< 5	< 6	< 6	< 6	< 5	< 8	< 5	< 5	< 7	< 5
Carbon Tetrachloride	100	ug/kg	< 6	< 5	< 5	< 5	< 5	< 6	< 6	< 6	< 5	< 8	< 5	< 5	< 7	< 5
Benzene	5300	ug/kg	100	61	< 5	< 5	< 5	8	< 6	< 6	< 5	< 8	< 5	< 5	21	< 5
1,2-Dichloropropane	19	ug/kg	< 6	< 5	< 5	< 5	< 5	< 6	< 6	< 6	< 5	< 8	< 5	< 5	< 7	< 5
Trichloroethylene	1100	ug/kg	< 6	< 5	< 5	13	< 5	< 6	< 6	< 6	< 5	< 8	< 5	< 5	< 7	< 5
Bromodichloromethane	25000	ug/kg	< 6	< 5	< 5	< 5	< 5	< 6	< 6	< 6	< 5	< 8	< 5	< 5	< 7	< 5
Cis-1,3-Dichloropropene	6.6(Total)	ug/kg	< 6	< 5	< 5	< 5	< 5	< 6	< 6	< 6	< 5	< 8	< 5	< 5	< 7	< 5
Methylisobutylketone	58000	ug/kg	< 26	< 20	< 20	< 20	< 20	< 24	< 24	< 26	< 20	< 32	< 20	< 20	< 28	< 20
t-1,3-Dichloropropene	6.6(Total)	ug/kg	< 6	< 5	< 5	< 5	< 5	< 6	< 6	< 6	< 5	< 8	< 5	< 5	< 7	< 5
1,1,2-Trichloroethane	3100	ug/kg	< 6	< 5	< 5	< 5	< 5	< 6	< 6	< 6	< 5	< 8	< 5	< 5	< 7	< 5
Toluene	34000	ug/kg	20	20	< 5	7	< 5	< 6	< 6	< 6	< 5	9	< 5	< 5	< 7	< 5
2-Hexanone	nv	ug/kg	< 26	< 20	< 20	< 20	< 20	34	< 24	< 26	< 20	< 32	< 20	< 20	< 28	< 20
Chlorodibromomethane	18000	ug/kg	< 6	< 5	< 5	< 5	< 5	< 6	< 6	< 6	< 5	< 8	< 5	< 5	< 7	< 5
1,2-Dibromoethane	nv	ug/kg	< 6	< 5	< 5	< 5	< 5	< 6	< 6	< 6	< 5	< 8	< 5	< 5	< 7	< 5
Tetrachloroethylene	450	ug/kg	< 6	< 5	< 5	< 5	< 5	< 6	< 6	< 6	< 5	< 8	< 5	< 5	< 7	< 5
1,1,2,2-Tetrachloroethane	37	ug/kg	< 6	< 5	< 5	< 5	< 5	< 6	< 6	< 6	< 5	< 8	< 5	< 5	< 7	< 5
Chlorobenzene	8000	ug/kg	69	45	< 5	< 5	< 5	< 6	22	< 6	< 5	< 8	< 5	< 5	< 7	< 5
Ethylbenzene	290000	ug/kg	71	42	< 5	< 5	< 5	< 6	< 6	< 6	< 5	< 8	< 5	< 5	< 7	< 5
m&p Xylenes	34000(Total)	ug/kg	73	24	< 5	< 5	< 5	8	< 6	< 6	< 5	< 8	< 5	8	9	12
Bromoform	2300	ug/kg	< 6	< 5	< 5	< 5	< 5	< 6	< 6	< 6	< 5	< 8	< 5	< 5	< 7	< 5
Styrene	1200	ug/kg	< 6	< 5	< 5	< 5	< 5	< 6	< 6	< 6	< 5	< 8	< 5	< 5	< 7	< 5
o-Xylene	34000(Total)	ug/kg	35	15	< 5	< 5	< 5	< 6	< 6	< 6	< 5	< 8	< 5	< 5	12	6
1,3-Dichlorobenzene	30000	ug/kg	< 6	< 5	< 5	< 5	< 5	8	< 6	< 6	< 5	< 8	< 5	< 5	< 7	< 5
1,4-Dichlorobenzene	30000	ug/kg	240	96	< 5	< 5	< 5	< 6	37	< 6	< 5	< 8	< 5	< 5	20	< 5
1,2-Dichlorobenzene	30000	ug/kg	< 6	8	13	< 5	< 5	< 6	8	< 6	< 5	< 8	< 5	< 5	< 7	< 5
Total Xylenes Calculated	34000	ug/kg	110	39	nd	nd	nd	8	nd	nd	nd	nd	nd	8	21	18
1,1,1,2-Tetrachloroethane	19	ug/kg	< 6	< 5	< 5	< 5	< 5	< 6	< 6	< 6	< 5	< 8	< 5	< 5	< 7	< 5
Total Petroleum Hydrocarbons																
TPH C6 - C10	1000(Total)	mg/kg	2.2	1.1	0.12	0.5	<0.1	5.15	5.13	<0.1	<0.1	1.59	<0.1	<0.1	2.3	<0.1
TPH C10 - C24	1000(Total)	mg/kg	4180	331	103	<40	<40	10900	585	537	<40	235	<40	<40	3620	107
TPH (Heavy Oil)	5000	mg/kg	54900	8680	495	260	<100	34300	2200	2690	133	1460	<100	249	5490	1160

NOTES "-" = not analysed, nv = no value
*1 = Ministry of the Environment, Guideline for Use at Contaminated Sites in Ontario, Feb 1997. Surface soil criteria for industrial/commercial land use for a non-potable groundwater condition. Criteria for course grained soil

TABLE E-8
RENNIE STREET LANDFILL
WASTE ANALYTICAL RESULTS
POLYCHLORINATED BIPHENYLS (PCBs)

Sample Location	Sample Depth (m.b.g.s)	PCB Concentration ug/g
MW6-11	3.0 - 6.5	1.25
MW6-12	3.0 - 6.5	0.44
MW6-13	3.0 - 6.5	1.05
BH6-14	7.6 - 9.8	580.9
BH6-14 (duplicate)	7.6 - 9.8	577.76
MW6-14a	1.5 - 6	1.79
MW6-14a	6 - 10.7	39.7
MW6-14a	7.6 - 8.2	4.21
MW6-14a	6.1 - 7.6	1.68
MW6-14a	9.1 - 9.7	3.35
MW6-14a	12.2 - 12.8	0.32
MW6-15	1.5 - 6.1	4.2
MW6-15	6.1- 10.7	6.64
MW6-15	7.6 - 9.1	5.57
BH6-16	1.5 - 6	3.39
BH6-16	6 - 10.5	3.54
BH6-16	7.6 - 9.1	2.31
BH6-17	1.8 - 6.1	5.12
BH6-17	6 - 7.5	11.69
BH6-17	7.6 - 9.1	0.53
BH6-18	1.5 - 6	0.51
BH6-18	6 - 7.5	86.15
BH6-18	4.6 - 6.1	0.34
BH6-18	7.6 - 9.1	618.52
BH6-19	1.5 - 6	2.11
BH6-19	7 - 7.5	8.48
BH6-20	6.1 - 7.6	1.08
BH6-20	7.6 - 9.1	3.54
BH6-20	3 - 4.6	2.72
MW6-21	0.8 - 1.4	<0.01
MW6-21	3 - 3.7	4.22
MW6-21	4.6 - 5.2	2.91
MW6-21	7.6 - 8.2	0.27
MW6-21	10.7 - 11.1	<0.01
MW6-22	0.8 - 1.4	<0.01
MW6-22	2.3 - 2.9	0.15
MW6-22	6.1 - 6.7	0.57
MW6-22	7.6 - 8.2	1.88
MW6-22	11.4 - 12.1	0.16
MW6-23	0.8 - 4.1	0.16
MW6-23	4.6 - 5.2	0.14
MW6-23	6.1 - 6.7	1.1
MW6-23	10.7 - 11.3	2.86
MW6-23	11.4 - 12.1	0.79

TABLE E-8
RENNIE STREET LANDFILL
WASTE ANALYTICAL RESULTS
POLYCHLORINATED BIPHENYLS (PCBs)

Sample Location	Sample Depth (m.b.g.s)	PCB Concentration ug/g
MW6-24	1.5 - 2.1	0.46
MW6-24	5.3 - 5.9	3.03
MW6-24	6.9 - 7.5	7.04
MW6-24	9.1 - 9.7	28.6
MW6-24	9.9 - 10.5	4.97
MW6-25	0.8 - 1.4	<0.01
MW6-25	2.3 - 2.9	0.31
MW6-25	6.1 - 6.7	5.79
MW6-25	9.9 - 10.5	0.96
MW6-26	0.8 - 1.4	0.37
MW6-26	3 - 3.7	0.94
MW6-26	6.9 - 7.5	1.61
MW6-26	9.1 - 9.7	12.15
MW6-26	10.7 - 11.3	0.38
MW6-27	0.8 - 1.4	<0.01
MW6-27	3 - 3.7	4.03
MW6-27	7.6 - 8.2	1.29
MW6-27	9.9 - 10.5	6.11
MW6-27	10.7 - 11.3	0.37
MW6-28	0.6 - 1.2	0.15
MW6-28	2.4 - 3	0.23
MW6-28	6.7 - 7.3	4.46
MW6-28	8.5 - 9.1	1.82
MW6-28	9.7 - 10.4	0.03
MW6-29	1.5 - 2.1	<0.01
MW6-29	3 - 3.7	0.09
MW6-29	6.1 - 7.5	15.2
MW6-29	9.9 - 10.5	3.52
MW6-29	11.4 - 12	<0.01
MW6-42	6.2-6.8	38.82
MW6-42	7.7-8.3	6.38
MW6-43	2.3-2.9	0.05
MW6-43	6.2-6.8	0.41
MW6-44	6.2-6.8	1.27
MW6-44	10.8-11.4	4.5
BH6-45	4.6-5.2	3.26
BH6-45	9.2-9.8	2.06
BH6-46	4.6-5.2	1.23
BH6-46	7.7-8.3	2.23
MW6-59	1.5 - 2.13	0.038
MW6-59	3.81 - 4.42	0.032
MW6-61	3.81 - 4.42	0.059
BH6-62	0.76 - 1.37	0.068
MW6-65	0 - 0.76	0.059
TP27 - 4'	1.21	<50
TP28 - 9.5'	2.89	3.2
TP31 - 5'	1.52	1.7
TP32 2-3'	0.6 - 0.9	0.12

TABLE E-8 RENNIE STREET LANDFILL WASTE ANALYTICAL RESULTS POLYCHLORINATED BIPHENYLS (PCBs)		
Sample Location	**Sample Depth (m.b.g.s)**	**PCB Concentration ug/g**
TP33 - 5'	1.52	1
TP34 7'	2.13	0.15
TP35 7'	2.13	0.23
TP36 9'	2.7	0.83
TP37B - 5'	1.52	2.1

Ministry of Environment, Guideline for Use at Contaminated Sites in Ontario, February 1997; PCB criteria for Industrial/Commercial Sites is 25 ug/g.

"m.b.g.s" = meters below ground surface

TABLE E-9
RENNIE STREET LANDFILL
WASTE ANALYTICAL RESULTS
REGULATION 347 LEACHATE EXTRACTION ANALYSIS

Parameter	Schedule 4 Criteria * mg/L	MW6-11 3.0 - 6.5 mg/L	MW6-12 3.0 - 6.5 mg/L	MW6-13 3.0 - 6.5 mg/L	MW6-14 7.6 - 9.8 mg/L
Arsenic	0.05	<0.01	<0.01	<0.01	<0.01
Barium	1	0.714	0.681	0.421	0.734
Boron	5	0.014	0.024	0.026	0.019
Cadmium	0.005	<0.003	<0.003	<0.003	<0.003
Chromium	0.05	<0.005	<0.005	<0.005	<0.005
Cyanide (Free)	0.2	<0.05	<0.05	<0.05	<0.05
Fluoride	2.4	<0.5	<0.5	<0.5	<0.5
Lead	0.05	<0.01	0.11	0.13	0.05
Mercury	0.001	<0.001	<0.001	<0.001	<0.001
Nitrate	10	<1	<1	<1	<1
Nitrite	10	<1	<1	<1	<1
Selenium	0.01	<0.01	<0.01	<0.01	<0.01
Silver	0.05	<0.01	<0.01	<0.01	<0.01

* General - Waste Management Regulation, R.R.O. 1990, Reg. 347, Schedule 4 - Leachate Quality Criteria.

TABLE E-10
RENNIE STREET LANDFILL
LEACHATE ANALYTICAL RESULTS
GENERAL CHEMISTRY AND METALS

Parameter	*1 MOE Table B Criteria	Sewer Use By-Law	Units	MW6-1 Sept 26/97	MW6-11 May /00	MW6-12 Sept 26/97	MW6-2 Sept 26/97	MW6-12 May 9/00	MW6-13 Sept 26/97	MW6-13 Sept 26/97 Dup	MW6-13 May 9/00	W101 Sept 26/97	MW6-21 Feb 12/99	MW6-21 May 10/00
Metals														
Aluminum	nv	50	mg/L	<0.01	3.56	0.07	2.78	1.92	1.78		0.07	3.35		0.74
Antimony	16	5	mg/L	<0.1	0.02	<0.1		< 0.005	<0.1	-	0.006		<0.01	< 0.005
Arsenic	0.48	1	mg/L	<0.1	0.03	<0.1		< 0.02	<0.1		< 0.2		<0.01	< 0.02
Barium	23	nv	mg/L	0.09	1.11	<0.01	<0.01	1.77	<0.01		2.76	<0.01		0.76
Beryllium	0.053	nv	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01		< 0.01	<0.01	<0.01	< 0.01
Bismuth	nv	5	mg/L	<0.1	< 0.01	<0.1		< 0.01	<0.1		< 0.01		<0.01	< 0.01
Boron	50	nv	mg/L	<0.01	37.5	<0.01	<0.01	2.26	<0.01		2.38	<0.01		20.8
Cadmium	0.011	1	mg/L	<0.01	< 0.001	<0.01	<0.01	< 0.001	<0.01		< 0.001	<0.01	<0.01	< 0.001
Calcium	nv	nv	mg/L	104.42	110	82.01	83.59	35.4	69.13	-	68.4	83.63		27.5
Chromium, total	2	5	mg/L	<0.01	0.11	<0.01	<0.01	< 0.05	<0.01	-	< 0.05	<0.01	0.01	< 0.5
Cobalt	0.1	5	mg/L	<0.01	0.043	<0.01	<0.01	0.007	<0.01		0.008	<0.01	<0.01	0.048
Copper	0.023	3	mg/L	<0.01	0.008	<0.01	<0.01	< 0.005	<0.01		< 0.005	<0.01	0.14	0.008
Iron	nv	50	mg/L	0.09	21.9	4.41	4.51	10	2.29		3.6	1.04	2.67	8
Lead	0.032	5	mg/L	<0.01	0.032	<0.01	<0.01	0.011	<0.01		< 0.005	<0.01	0.01	0.075
Magnesium	nv	nv	mg/L	96.47	159	54.99	52.42	68.3	80.18		144	77.33		83.1
Manganese	nv	5	mg/L	<0.01	0.34	<0.01	<0.01	0.08	<0.01		0.09	<0.01	<0.01	0.05
Mercury	0.12	100	ug/L	<0.05	0.1	<0.05		0.2	0.14		0.9	-		0.1
Molybdenum	7.3	5	mg/L	<0.01	< 0.01	<0.01	<0.01	< 0.01	<0.01		0.04	<0.01	<0.01	< 0.01
Nickel	1.6	3	mg/L	<0.01	0.19	<0.01	0.07	< 0.01	0.16		0.03	0.06	<0.01	0.19
Potassium	nv	nv	mg/L	104.34	392	89.97	240.18	65	307.21		231	210.08	-	368
Selenium	0.05	5	mg/L	<0.1	< 0.02	<0.1		< 0.02	<0.1	-	< 0.2	-	0.02	< 0.02
Silicon	nv	nv	mg/L	10.54		7.81	11.11		8.61		-	10.94		-
Silver	0.0012	5	mg/L	<0.01	< 0.001	<0.01	<0.01	0.001	<0.01		< 0.001	<0.01	<0.01	< 0.001
Sodium	nv	nv	mg/L	1448	2260	2139	1931	2220	12150	-	17200	950.23		2210
Strontium	nv	nv	mg/L	<0.01	2.35	<0.01	<0.01	0.8	<0.01	-	2.64	<0.01		0.46
Thallium	0.4	nv	mg/L		< 0.0005			< 0.0005	-		< 0.0005	-		< 0.0005
Tin	nv	5	mg/L	0.2	0.25	<0.05	-	0.03	<0.05	-	0.01	-	<0.01	0.39
Titanium	nv	5	mg/L	<0.01	0.28	<0.01	<0.01	0.1	<0.01	-	< 0.05	<0.01	<0.01	0.13
Uranium	nv	nv	mg/L		< 0.001			< 0.001	-		< 0.001	-		< 0.001
Vanadium	0.2	5	mg/L	<0.01	0.046	<0.01	<0.01	< 0.005	<0.01		< 0.05	<0.01	<0.01	0.167
Zinc	1.1	3	mg/L	<0.01	0.34	<0.01	<0.01	0.19	<0.01	-	< 0.05	<0.01	0.03	0.22
General Chemistry														
Conductivity (field)	nv	nv	us/cm	-	US		-	US	-	-	US	-	-	US
Temperature (field)	nv	nv	Celcius		15			17.3		-	17.3	-	-	14.1
pH (field)	nv	nv	pH units		6.79			6.55	-	-	7.67	-		7.3
pH (lab)	nv	5.5 - 9.5	pH units	7.1	7.53	7.05	7.22	7.62	7.35	-	8.47	7.69	7.32	7.75
Ammonia-N	nv	nv	mg/L	409.5	123	102.75	128.75	89.9	230.5	-	191	303.75	13.7	522
TKN	nv	100	mg/L	510.65	897	186.45	194.7	121	298.74	-	286	406.5	91.7	1420
Nitrate as N	nv	nv	mg/L		0.22			< 0.1		-	< 0.1	-	-	0.13
Nitrite as N	2	nv	mg/L		0.03			< 0.02	-	-	< 0.02	-	-	0.12
Nitrate-Nitrite-N	nv	nv	mg/L	0.19	0.25	0.15	0.14	< 0.1	0.05	-	< 0.1	0.15	-	0.25
TOC	nv	nv	mg/L							-	-	-	-	
DOC	nv	nv	mg/L	238	356	191.4	208	57.9	193	-	126	254	-	388
Total Phosphorus as P	nv	10	mg/L	<0.01	3.62	<0.01	<0.01	0.38	<0.01	-	1.38	<0.01	8.6	13.4
Phosphorus Diss. Orth as P	nv	nv	mg/L		< 0.05		-	< 0.01		-	1.44	-	-	9.6
Conductivity (Lab)	nv	nv	us/cm		15700		-	10200	-	-	63000	-	-	17100
Solids Suspended	nv	nv	mg/L					-			-	-		-
Sulphate	nv	1500	mg/L	228.58	49	89.18	93.08	11	72.61	-	40	109.96	620	68
Alkalinity	nv	nv	mg/L	4232.5	5440	1505.9	1520.85	1530	815.85	-	500	2257.75	1300	6520
BOD	nv	300	mg/L	87.3	168	5.3		6	97.4	-	83	-	670	73
Chloride	nv	1500	mg/L	2022.75	2600	2571.75	2601.25	2750	22190	23069	26600	2030.75	1770	2840
Colour	nv	nv	TCU		1060			144	-	-	103	-		6390
Silica Reactive as SiO2	nv	nv	mg/L		21			16.3	-	-	2.81	-	-	29.3
Calculated Hardness CaCO3	nv	nv	mg/L		329		-	361		-	759	-	-	411
Turbidity	nv	nv	NTU		1030			109		-	43.2	-	-	1030
Total Phenols	26000	1	ug/L	<2	65	<2	<7	13	201	-	252	<9	<2	207
Fluoride	nv	10	mg/L	0.1	-	1.39	0.15		0.13	-	-	0.09	0.31	-
TSS	nv	nv	mg/L	1920	-	11800			774	-	-	-	3090	-
Total Cyanide	0.052	2	mg/L	<0.001	0.031	0.001		0.013	0.005	-	0.071	-	<0.05	-
O & Grease, Min/Syn	nv	15	mg/L	4		2			11	-		-	2	-
O & Grease, Animal/Veg	nv	150	mg/L	6		5		-	11	-	-	-	4	-

Parameter	MW6-22 Apr 27/98	MW6-23 May 10/00	MW6-23 May 10/00 Dup	MW6-25 May /00	MW6-42 /98	MW6-42 May /00	MW6-43 Oct 13/98	MW6-43 /98 Dup	MW6-44 /98	MW6-44 May 10/00	MW6-47 May /00	MW6-48 May 11/00	MW6-49A May /00	MW6-49B May 12/00	MW6-49B May /00 Dup
Metals															
Aluminum		3.26	3.45	0.28	<0.03	< 0.5	<0.03	<0.03	<0.03	0.15	2	0.341	0.011	0.011	0.18
Antimony	<0.01	< 0.005	< 0.005	< 0.005	<0.1	< 0.05	<0.1	<0.1	<0.1	< 0.005	0.004	0.004	0.008	0.002	[illegible]
Arsenic	<0.01	< 0.02	< 0.02	< 0.02	<0.1	[illegible]	<0.1	<0.1	<0.1	< 0.02	0.082	0.003	< 0.005	0.004	[illegible]
Barium		1.6	0.47	0.89	0.02	2.82	0.01	[illegible]	0.62	1.39	1.2	1.41	1	[illegible]	[illegible]
Beryllium	<0.01	< 0.01	< 0.01	< 0.01	<0.01	< 0.1	<0.01	<0.01	<0.01	[illegible]	< 0.001	< 0.001	[illegible]	< 0.001	[illegible]
Bismuth	0.01	< 0.01	< 0.01	< 0.01	<0.1	[illegible]	<0.1	<0.1	<0.1	[illegible]	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Boron	-	10	9.55	12	<0.01	3.34	<0.01	<0.1	<0.01	8.87	9.37	4.13	0.46	2.45	2.8
Cadmium	<0.01	< 0.001	< 0.001	< 0.001	<0.01	< 0.01	<0.01	<0.01	<0.01	< 0.001	0.0002	0.0001	0.0001	< 0.0001	< 0.0001
Calcium		12.9	13.6	49.1	98.11	86.4	31.08	[illegible]	105.9	42.1	151	118	673	146	176
Chromium, total	0.01	< 0.5	< 0.5	< 0.5	<0.01	< 0.5	<0.01	<0.01	<0.1	< 0.5	< 0.05	< 0.05	< 0.005	< 0.005	[illegible]
Cobalt	0.04	0.031	0.031	0.028	<0.01	< 0.01	<0.01	<0.01	<0.01	0.023	0.014	0.008	0.003	0.003	0.003
Copper	0.02	0.013	0.012	0.01	<0.01	< 0.05	<0.01	<0.01	0.02	0.008	0.011	0.002	< 0.005	0.002	[illegible]
Iron	4.38	4.8	4.9	2.6	9	23.3	1.89	1.6	17.2	7.8	1.62	8.12	< 0.03	[illegible]	[illegible]
Lead	<0.01	0.166	0.167	0.045	0.31	< 0.05	0.11	<0.01	0.13	0.01	0.0212	0.0061	< 0.0005	< 0.0005	< 0.0005
Magnesium	-	80.6	80.7	79.3	120.6	167	153.5	128.2	129.5	124	127	165	675	93.6	[illegible]
Manganese	1.09	< 0.05	< 0.05	0.13	0.2	< 0.5	0.5	0.32	0.4	0.05	0.188	0.235	0.305	0.167	0.234
Mercury	<10	0.1	0.1	0.1	<0.05	0.1	<0.05	0.19	<0.05	< 0.1	0.2	0.1	< 0.1	0.1	< 0.1
Molybdenum	0.01	< 0.01	< 0.01	< 0.01	<0.01	< 0.1	<0.01	<0.01	<0.01	< 0.01	0.006	< 0.002	0.017	0.011	0.012
Nickel	0.02	0.09	0.09	0.07	<0.01	< 0.1	<0.01	<0.01	<0.01	0.05	0.058	0.007	0.007	0.003	0.004
Potassium		315	311	298	303.8	260	146.5	159.5	246	179	209	97.3	67.4	33.4	40.9
Selenium	0.01	< 0.02	< 0.02	< 0.02	<0.1	0.2	<0.1	[illegible]	<0.1	< 0.02	< 0.002	< 0.002	0.004	< 0.002	< 0.002
Silicon			-		12.29		11.73	11.76	3.99	-	-	-	-	-	-
Silver	<0.001	< 0.001	< 0.001	< 0.001	<0.01	< 0.01	<0.01	[illegible]	[illegible]	< 0.001	0.0064	< 0.0001	< 0.0001	< 0.0001	[illegible]
Sodium		1600	1590	1380	5867	9400	2376	2388	2691	1990	1650	944	559	[illegible]	204
Strontium	-	0.38	0.38	1.09	0.89	1.85	0.39	0.41	0.79	1.91	2.78	1.35	5.11	3.29	[illegible]
Thallium	-	< 0.0005	< 0.0005	< 0.0005		< 0.005				< 0.0005	< 0.0002	< 0.0002	< 0.0002	< 0.0002	[illegible]
Tin	0.02	0.69	0.69	0.44	<0.05	< 0.1	0.07	0.07	0.18	0.19	0.05	0.007	< 0.002	< 0.002	< 0.002
Titanium	0.01	0.21	0.25	0.11	<0.01	< 0.5	<0.01	<0.01	<0.01	0.05	0.16	0.023	< 0.005	< 0.005	< 0.005
Uranium	-	< 0.001	< 0.001	< 0.001	-	< 0.01	-	-	-	< 0.001	0.0006	< 0.0001	0.0432	0.006	0.0069
Vanadium	0.11	0.029	0.025	0.023	<0.01	< 0.05	<0.01	<0.01	<0.01	0.014	0.023	< 0.05	< 0.005	< 0.005	< 0.005
Zinc	0.01	0.34	0.27	0.13	<0.01	< 0.5	<0.01	<0.01	<0.01	0.28	0.378	0.465	0.25	0.298	0.418
General Chemistry															
Conductivity (field)	-	US		US	-	US				US	US	US	US	US	-
Temperature (field)	-	14.1		16.6		14.3				11.3	15.3	15	15.2	12.1	-
pH (field)	-	6.73		7.38		6.71				7.43	7	6.46	6.12	6.56	-
pH (lab)	7.3	8.17	8.15	7.87	7.16	7.48	7.4	7.36	7.74	7.79	7.84	7.46	7.51	7.94	7.82
Ammonia-N	2.2	489	709	526	72.5	424	32.8	48	93.2	807	703	189	0.83	1.92	2.8
TKN	58	889	792	1070	17.9	639	11.5	21	18	853	838	473	1.63	3.69	2.88
Nitrate as N		< 0.1	0.13	< 0.1	-	0.22			-	0.12	0.61	0.2	3.24	< 0.1	< 0.1
Nitrite as N		0.08	< 0.02	< 0.02	-	< 0.02				< 0.02	0.02	< 0.02	0.33	0.03	< 0.02
Nitrate-Nitrite-N	-	0.1	0.13	< 0.1	0.29	0.22	0.14	0.8	170	0.12	0.63	0.2	3.27	< 0.1	< 0.1
TOC	-	-	-	-	-		-			-	-	-		-	
DOC	-	228	238	232	-	277	-		-	165	220	77.5	< 5	6.1	4
Total Phosphorus as P	0.11	3.92	3.88	7.59	<0.01	0.16	<0.01	<0.01	19.27	4.9	9.94	0.58	0.01	< 0.002	0.004
Phosphorus Diss. Orth as P	-	2.47	2.34	5.95	-	< 0.01	-			2.27	10.2	< 0.01	0.01	< 0.01	< 0.01
Conductivity (Lab)	-	12300	12300	11500	35590	42200	14290		35600	15300	11100	8000	8520	1860	2430
Solids Suspended		-													
Sulphate	620	34	32	49	175	37	80.8	76.6	74.5	32	298	8	380	146	169
Alkalinity	391	3600	3660	3660	461.4	2190	460.8	458.4	439.5	4000	2700	2300	170	276	338
BOD	410	97	85	71	26.8	27	10.4	11.9	62.5	36	529	67	< 2	9	< 2
Chloride	1090	2500	2490	1990	10800	17700	3545	3725	4200	3330	2330	1390	3500	416	586
Colour	-	4480	4320	5180	-	286				490	383	160	< 5	< 5	< 5
Silica Reactive as SiO2	-	27.5	27.3	34.7	-	17.1	-		-	-	45.8	32.3	13.5	9.6	10.4
Calculated Hardness CaCO3	-	364	366	452	-	903	-			516	900	977	4460	750	938
Turbidity	-	312	400	58	200	72.5	115		640	145	390	46.7	16.6	11.4	15.4
Total Phenols	<2	150	173	236	<2	39	<2	<2	<2	230	1970	39	1	< 1	1
Fluoride	0.21	-	-	-	<0.01	-	<0.01	<0.01	<0.01	-	-	-	-	-	-
TSS	390	-	-	-	7250		10300	10100	1070	-		-	-	-	-
Total Cyanide	<0.05	-	-	-	0.002	-	0.006	0.005	<0.001	-		-	-	-	-
O & Grease, Min/Syn		-	-	-	3	-	2	3	4	-		-	-	-	
O & Grease, Animal/Veg	-	-	-	-	4	-	7	11	16	-	-	-	-	-	-

NOTES: "-" = not analysed. nv = no value, US = conductivity meter unservicable

*1 = Ministry of the Environment, Guideline for use at Contaminated Sites in Ontario, Feb 1997, Surface soil criteria for all land uses for a non-potable groundwater condition, criteria for course grained soil

Dup = Duplicate sample

TABLE E-10 Con't
RENNIE STREET LANDFILL
LEACHATE ANALYTICAL RESULTS
GENERAL CHEMISTRY AND METALS

Parameter	*1 MOE Table B Criteria	Sewer Use By-Law	Units	MW6-50	MW6-51A	MW6-51B	MW6-52A	MW6-52B	MW6-53A	MW6-53B	MW6-57	MW6-58A	MW6-58B	MW6-59	MW6-59	MW6-60	MW6-61	GW1	GW4	GW8	SP2
			Date	May 1/00	May 8/00	May 17/00	May 17/00	May 17/00	May 17/00	May 17/00	June 21/00	July 13/00	July 12/00	July 12/00	July 12/00	July 12/00	July 12/00	June 21/00	June 21/00	June 21/00	May 18/00
															Dup						
Metals																					
Aluminum	nv	50	mg/L	1.023	< 0.05	< 0.05	2.14	0.073	< 0.05	< 0.05	0.124	0.052	< 0.01	< 0.05	0.24	0.145	0.016	0.178	0.015	0.01	0.026
Antimony	16	5	mg/L	0.003	< 0.005	< 0.005	< 0.002	< 0.005	0.008	< 0.005	0.003	0.005	0.007	< 0.005	0.005	0.003	0.002	0.006	0.013	0.002	< 0.002
Arsenic	0.48	1	mg/L	< 0.002	< 0.02	< 0.02	0.003	< 0.02	< 0.2	0.022	0.005	< 0.005	< 0.02	< 0.02	< 0.02	0.007	< 0.002	< 0.02	0.014	< 0.02	< 0.002
Barium	21	nv	mg/L	0.781	1.46	2.53	1.32	2.15	1.42	3.23	1.07	1.11	0.424	2.67	2.9	0.567	0.304	0.748	1.13	1.03	0.062
Beryllium	1.53	nv	mg/L	< 0.001	< 0.01	< 0.01	< 0.001	< 0.01	< 0.01	< 0.01	< 0.001	< 0.001	< 0.001	< 0.01	< 0.01	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Bismuth	nv	5	mg/L	< 0.002	< 0.01	< 0.01	< 0.002	< 0.01	< 0.01	< 0.01	< 0.002	< 0.002	< 0.002	< 0.01	< 0.01	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Boron	50	nv	mg/L	3.64	3.05	0.73	3.4	0.57	2.62	1.33	1.68	0.4	8.82	0.64	0.64	2.95	0.88	0.63	0.19	0.43	0.1
Cadmium	0.11	1	mg/L	0.0001	< 0.001	< 0.001	0.0001	< 0.001	< 0.001	< 0.001	0.001	< 0.0001	< 0.0001	< 0.001	< 0.001	0.0001	< 0.0001	< 0.001	< 0.0001	< 0.0001	< 0.0001
Calcium	nv	nv	mg/L	127	458	478	52.7	416	227	658	158	149	540	530	539	312	298	482	89.3	211	39.5
Chromium (total)	2	5	mg/L	< 0.01	< 0.05	< 0.05	0.059	< 0.05	0.065	< 0.05	0.009	< 0.005	< 0.005	0.218	0.148	< 0.005	< 0.005	< 0.005	0.006	0.006	< 0.005
Cobalt	2.1	5	mg/L	0.003	0.018	0.02	0.007	0.006	0.008	0.007	0.004	0.003	0.002	0.006	0.005	0.003	0.002	0.001	0.002	0.002	< 0.001
Copper	0.023	3	mg/L	0.003	0.026	< 0.005	0.01	< 0.005	< 0.005	< 0.005	0.004	< 0.002	0.006	< 0.005	< 0.005	0.003	0.002	< 0.005	0.04	< 0.002	0.003
Iron	nv	50	mg/L	< 0.03	13.7	6.9	3.31	88.4	0.78	128	8.51	0.03	0.81	65.9	62.5	0.22	1.9	0.63	< 0.03	12.8	0.06
Lead	0.032	5	mg/L	< 0.0005	< 0.005	< 0.005	0.015	< 0.005	< 0.005	< 0.005	0.0061	< 0.0005	< 0.0005	< 0.005	< 0.005	< 0.0005	0.0132	0.002	0.0042	< 0.0005	< 0.0005
Magnesium	nv	nv	mg/L	165	153	157	15.3	124	160	248	44.5	29.7	185	65.4	68.3	59.1	30.3	19.5	< 0.02	46.8	29.9
Manganese	nv	5	mg/L	0.348	7	3.79	0.651	3.8	3.61	4.47	0.831	1.61	0.348	1.1	1.08	11.1	1.42	3.34	< 0.005	1.41	0.045
Mercury	0.12	100	ug/L	0.2	1.2	0.5	0.1	<0.2	<0.2	<0.2	0.1	< 0.1	< 0.1	0.3	0.2	0.3	0.1	-	0.1	0.2	-
Molybdenum	7.3	5	mg/L	0.01	< 0.01	< 0.01	0.002	< 0.01	< 0.01	< 0.01	0.012	0.004	0.007	< 0.01	< 0.01	0.003	0.002	0.354	0.03	< 0.002	0.003
Nickel	1.6	3	mg/L	0.004	0.065	0.028	0.009	< 0.01	0.026	< 0.01	0.007	0.003	0.004	< 0.01	< 0.01	0.004	0.002	0.014	0.007	< 0.002	0.002
Potassium	nv	nv	mg/L	81.5	43.2	60.5	7.58	19	166	61.1	26.7	6.59	62.7	54.1	55.3	3.45	7.14	24.3	11.8	8.3	4.98
Selenium	0.35	5	mg/L	0.002	< 0.02	< 0.02	< 0.002	< 0.02	< 0.02	< 0.02	< 0.002	< 0.002	< 0.002	< 0.02	< 0.02	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Silicon	nv	nv	mg/L					-	-	-		-		-	-	-	-	-			-
Silver	0.0012	5	mg/L	< 0.0001	< 0.001	< 0.001	< 0.0001	< 0.001	< 0.001	< 0.001	< 0.0001	< 0.0001	< 0.0001	< 0.001	< 0.001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Sodium	nv	nv	mg/L	99.9	997	1330	120	1480	10300	3060	521	847	890	12900	12700	202	257	3880	1210	527	139
Strontium	nv	nv	mg/L	1.2	4.58	8.95	0.501	4.83	3.31	10.5	1.62	0.475	18	6.59	6.26	1.25	2.47	3.25	0.744	1.17	1.47
Thallium	0.4	nv	mg/L	< 0.0002	< 0.0005	< 0.0005	< 0.0002	< 0.0005	< 0.0005	< 0.0005	0.0002	< 0.0002	0.0002	0.001	0.001	< 0.0002	< 0.0002	0.0002	0.0002	0.0002	< 0.0002
Tin	nv	5	mg/L	< 0.002	< 0.01	< 0.01	< 0.002	< 0.01	< 0.01	< 0.01	0.003	< 0.002	< 0.002	< 0.01	< 0.01	< 0.002	< 0.002	< 0.002	0.004	0.002	< 0.002
Titanium	nv	5	mg/L	< 0.005	< 0.05	< 0.05	0.017	< 0.05	< 0.05	< 0.05	0.01	< 0.005	< 0.005	< 0.05	< 0.05	< 0.005	0.005	0.007	0.006	< 0.005	< 0.005
Uranium	nv	nv	mg/L	0.008	0.0046	< 0.001	0.0009	< 0.001	< 0.001	< 0.001	0.0049	0.0032	0.0008	< 0.001	< 0.001	0.004	0.0016	0.0111	< 0.0001	0.0002	0.0024
Vanadium	0.2	5	mg/L	0.005	0.005	0.008	0.004	< 0.005	< 0.05	< 0.05	0.011	< 0.005	< 0.005	< 0.005	< 0.005	0.01	0.008	< 0.005	0.133	0.003	< 0.002
Zinc	1.1	3	mg/L	0.349	0.112	0.401	0.218	0.47	0.061	0.508	0.467	0.179	0.235	< 0.05	0.081	0.285	0.203	0.01	0.051	0.325	< 0.005
General Chemistry																					
Conductivity (field)	nv	nv	us/cm	US	US	US	US	US	US	US	3900	4700	6900	>20000	>20000	2500	2600	16200	6300	3800	
Temperature (field)	nv	nv	Celcius	12.8	11.7	17.5	13	12	14.5	11.5	18.4	15	13.6	16.7	16.7	14	14	22	19.3	18	-
pH (field)	nv	nv	pH units	6.34	6.98	6.56	7.6	6.5	6.5	6.1	7.06	7.5	7.5	7.28	7.28	7.48	7.2	-	10.76	-	
pH (lab)	nv	5.5 - 9.5	pH units	7.77	7.62	7.2	8.08	7.25	7.89	6.74	7.57	7.56	7.55	6.94	6.97	7.46	7.5	7.97	10.3	7.22	8.12
Ammonia-N	nv	nv	mg/L	0.26	199	230	7.99	20.4	181	47.9	7.61	<0.05	5.64	60	69.6	0.77	0.79	6.34	3.58	11	0.8
TKN	nv	100	mg/L	0.31	210	252	9.19	23.3	217	55.6		-	7.74	63.8	67.9	1.55	1.32	-	-	-	2.54
Nitrate as N	nv	nv	mg/L	< 0.1	< 0.1	< 0.1	0.43	< 0.1	< 0.1	< 0.1	0.74	<0.1	4.28	< 0.1	< 0.1	< 0.1	< 0.1	<0.1	<0.1	<0.1	1.55
Nitrite as N	2	nv	mg/L	< 0.02	0.75	< 0.02	0.37	< 0.02	0.02	< 0.02	0.12	<0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	<0.02	0.53	<0.02	0.09
Nitrate/Nitrite-N	nv	nv	mg/L	< 0.1	< 0.1	< 0.1	0.8	< 0.1	< 0.1	< 0.1	0.86	<0.1	4.28	< 0.1	< 0.1	< 0.1	< 0.1	<0.1	0.6	<0.1	1.64
TSS	nv	nv	mg/L					-	-	-			-	-	-	-	-	-	-	-	
DOC	nv	nv	mg/L	6.2	109	140	7.7	49.7	157	41.2	20.2	37.5	< 2.5	< 50	< 50	20.7	9.5	76.9	16	27.5	4.3
Total Phosphorus as P	nv	10	mg/L	0.01	0.141	0.044	0.074	0.45	0.045	0.01	0.69	0.07	0.009	0.984	0.018	0.029	0.038	<0.01	0.09	1.41	0.38
Phosphorus Diss. Orth as P	nv	nv	mg/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.05	< 0.01	0.13	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	<0.01	<0.01	<0.01	< 0.01
Conductivity (lab)	nv	nv	us/cm	1910	6690	8740	978	8180	38900	15300	3260	4560	7270	54400	53900	1960	2330	17400	5810	3250	1270
Solids Suspended	nv	nv	mg/L					-			-	-	-	-	-		-		-		
Sulphate	nv	1500	mg/L	145	14	10	16	4	22	2	209	195	1640	19	19	284	396	425	168	16	164
Alkalinity	nv	nv	mg/L	470	2630	3040	195	1050	1460	990	500	236	66	500	501	771	440	121	162	903	188
BOD	nv	300	mg/L	< 2	22	24	2	12	10	7	-	< 2	< 2	4	2	< 2	< 2	-	-	-	-
Chloride	nv	1500	mg/L	320	1510	1830	213	2750	16700	5490	865	1410	2010	24200	24700	260	362	8050	1830	727	231
Colour	nv	nv	TCU	< 5	95	158	10	35	154	19	27	6	8	16	12	25	12	105	37	72	10
Silica, Reactive as SiO2	nv	nv	mg/L	16.9	16.5	16.7	2.16	15.5	14.5	19.7	22.5	10.1	6.86	12.1	11.6	15	32.1	9.91	73.9	36.7	3.58
Calculated Hardness CaCO3	nv	nv	mg/L	997	1770	1840	195	1550	1230	2660	578	494	2110	1590	1620	1020	869	1280	223	720	372
Turbidity	nv	nv	NTU	11	338	85.8	64.6	157	42.2	540	43.2	34.1	17.7	306	306	23.6	21.6	40.4	25.2	14.2	404
Total Phenols	16000	1	ug/L	1	2	4	2	1	8	4	2	< 1	1	12	12	1	< 1	-	7	1	-
Flouride	nv	10	mg/L		-		-	-	-	-			-	-	-		-	-	-	-	-
TSS	nv	nv	mg/L					-	-	-			-	-	-	-	-	-	-	-	-
Total Cyanide	0.052	2	mg/L				-	-	-	-				0.015	0.014	-	-	-	-	0.003	-
Oil & Grease (Min./Syn.)	nv	15	mg/L				-	-			-		-		-	-	-	-	-	-	-
Oil & Grease (Animal/Veg)	nv	150	mg/L							-	-		-	-	-	-	-	-	-	-	-

NOTES: "-" = not analysed, nv = no value, US =conductivity meter unservicable
*1 = Ministry of the Environment Guideline for use at Contaminated Sites in Ontario Feb 1997 Surface soil criteria for all land uses for a non-potable groundwater condition criteria for course grained soil
Dup = Duplicate sample

TABLE E-11
RENNIE STREET LANDFILL
LEACHATE ANALYTICAL RESULTS
VOLATILE ORGANIC COMPOUNDS (VOCs) TOTAL PETROLEUM HYDROCARBONS (TPH)

Sample Designation			MW6-11	MW6-11	MW6-12	MW6-12	MW6-12	MW6-13	MW6-13	W101	SPRING	MW6-21	MW6-23	MW6-23	MW6-25	MW6-42	MW6-42	MW6-43	MW6-43	MW6-44	MW6-44	MW6-47	MW6-48
Sample Date			Sept 26/97	May 9/00	Sept 26/97	Sept 26/97	May 9/00	Sept 26/97	May 9/00	Sept 26/97	Oct 21/97	May 10/00	May 10/00	May 10/00	May 10/00	Oct 13/98	May 10/00	Oct 13/98	Oct 13/98	Oct 13/98	May 10/00	May 11/00	May 11/00
Parameter	*1 MOE Table B Criteria	Units												Dup					Dup				
VOC'S																							
Chloromethane	nv	ug/L	< 0.1	< 4.3	< 0.1	< 0.1	< 4.3	< 0.1	< 4.3	< 0.1	< 0.1	< 22	< 22	< 22	< 22	<0.1	< 22	<0.1	<0.1	<0.1	< 22	< 22	< 22
Vinyl Chloride	0.5	ug/L	< 0.1	14	< 0.1	< 0.1	< 4.3	< 0.1	< 4.3	< 0.1	< 0.1	< 22	< 22	< 22	< 22	<0.1	< 22	<0.1	<0.1	<0.1	< 22	< 22	< 22
Bromomethane	3.7	ug/L	< 0.1	< 4.3	< 0.1	< 0.1	< 4.3	< 0.1	< 4.3	< 0.1	< 0.1	< 22	< 22	< 22	< 22	<0.1	< 22	<0.1	<0.1	<0.1	< 22	< 22	< 22
Chloroethane	nv	ug/L	-	< 4.3		-	< 4.3	-	< 4.3	-	-	< 22	< 22	< 22	< 22	-	< 22	-	-	-	< 22	< 22	< 22
Trichlorofluoromethane	nv	ug/L	< 0.1	< 2.6	< 0.1	< 0.1	< 2.6	< 0.1	< 2.6	< 0.1	< 0.1	< 13	< 13	< 13	< 13	<0.1	< 13	<0.1	<0.1	<0.1	< 13	< 13	< 13
Acetone	3300	ug/L	-	< 17	-	-	< 17	-	85	-	-	140	140	120	120	-	120		-	-	110	130	130
1,1-Dichloroethene	0.66	ug/L	< 0.1	< 1.7	< 0.1	< 0.1	< 1.7	< 0.1	< 1.7	< 0.1	< 0.1	< 8.6	< 8.6	< 8.6	< 8.6	<0.1	< 8.6	<0.1	<0.1	<0.1	< 8.6	< 8.6	< 8.6
Dichloromethane	50000	ug/L	< 0.1	< 9	< 0.1	< 0.1	< 9	< 0.1	< 9	< 0.1	< 0.1	< 43	< 43	< 43	< 43	<0.1	45	<0.1	<0.1	<0.1	54	86	74
t-1,2-Dichloroethene	100	ug/L	< 0.1	< 1.7	< 0.1	< 0.1	< 1.7	< 0.1	< 1.7	< 0.1	< 0.1	< 8.6	< 8.6	< 8.6	< 8.6	<0.1	< 8.6	<0.1	<0.1	<0.1	< 8.6	< 8.6	< 8.6
Methyl-t-butyl Ether(MTBE)	50000	ug/L	-	< 8.6	-	-	< 8.6	-	< 8.6	-	-	< 43	< 43	< 43	< 43	-	< 43		-	-	< 43	< 43	< 43
1,1-Dichloroethane	9000	ug/L	< 0.1	< 1.7	< 0.1	< 0.1	< 1.7	< 0.1	< 1.7	< 0.1	< 0.1	12	< 8.6	< 8.6	< 8.6	<0.1	< 8.6	<0.1	<0.1	<0.1	< 8.6	< 8.6	< 8.6
Methyl Ethyl Ketone	50000	ug/L	-	< 17	-	-	< 17	-	< 17	-	-	< 86	< 86	< 86	< 86	-	< 86	-	-	-	< 86	< 86	< 86
cis-1,2-Dichloroethylene	70	ug/L	-	2.1	-	-	< 1.7	-	2.5	-	-	< 8.6	< 8.6	< 8.6	< 8.6	-	< 8.6	-	-	-	< 8.6	< 8.6	< 8.6
Chlorobromomethane	nv	ug/L	-	< 1.7	-	-	< 1.7	-	< 1.7	-	-	< 8.6	< 8.6	< 8.6	< 8.6	-	< 8.6	-	-	-	< 8.6	< 8.6	< 8.6
Chloroform	430	ug/L	< 0.1	< 1.7	< 0.1	< 0.1	< 1.7	< 0.1	< 1.7	< 0.1	< 0.1	< 8.6	< 8.6	< 8.6	< 8.6	<0.1	< 8.6	<0.1	<0.1	<0.1	< 8.6	< 8.6	< 8.6
1,2-Dichloroethane	17	ug/L	< 0.1	< 1.7	< 0.1	< 0.1	< 1.7	< 0.1	1.8	< 0.1	< 0.1	< 8.6	< 8.6	< 8.6	< 8.6	<0.1	< 8.6	<0.1	<0.1	<0.1	< 8.6	< 8.6	< 8.6
1,1,1-Trichloroethane	200	ug/L	< 0.1	< 1.7	< 0.1	< 0.1	< 1.7	< 0.1	< 1.7	< 0.1	< 0.1	< 8.6	< 8.6	< 8.6	< 8.6	<0.1	< 8.6	<0.1	<0.1	<0.1	< 8.6	< 8.6	< 8.6
Carbon Tetrachloride	17	ug/L	< 0.1	< 1.7	< 0.1	< 0.1	< 1.7	< 0.1	< 1.7	< 0.1	< 0.1	< 8.6	< 8.6	< 8.6	< 8.6	<0.1	< 8.6	<0.1	<0.1	<0.1	< 8.6	< 8.6	< 8.6
Benzene	1900	ug/L	< 0.1	5.8	< 0.1	< 0.1	5.4	< 0.1	24	< 0.1	< 0.1	11	12	11	10	38	< 8.6	29	40	24	49	47	16
1,2-Dichloropropane	9.3	ug/L	< 0.1	< 1.7	< 0.1	< 0.1	< 1.7	< 0.1	< 1.7	< 0.1	< 0.1	< 8.6	< 8.6	< 8.6	< 8.6	<0.1	< 8.6	<0.1	<0.1	<0.1	< 8.6	< 8.6	< 8.6
Trichloroethene	50	ug/L	< 0.1	< 1.7	< 0.1	< 0.1	< 1.7	< 0.1	< 1.7	< 0.1	< 0.1	< 8.6	< 8.6	< 8.6	< 8.6	<0.1	< 8.6	<0.1	<0.1	<0.1	< 8.6	< 8.6	< 8.6
Bromodichloromethane	50000	ug/L	< 0.1	< 1.7	< 0.1	< 0.1	< 1.7	< 0.1	< 1.7	< 0.1	< 0.1	< 8.6	< 8.6	< 8.6	< 8.6	<0.1	< 8.6	<0.1	<0.1	<0.1	< 8.6	< 8.6	< 8.6
cis-1,3-Dichloropropene	3.8 (Total)	ug/L	< 0.1	< 4.3	< 0.1	< 0.1	< 4.3	< 0.1	< 4.3	< 0.1	< 0.1	< 22	< 22	< 22	< 22	<0.1	< 22	<0.1	<0.1	<0.1	< 22	< 22	< 22
Methyl Isobutyl Ketone	50000	ug/L	-	25	-	-	< 17	-	30	-	-	< 86	< 86	< 86	< 86	-	< 86	-	-	-	< 86	< 86	< 86
t-1,3-Dichloropropene	3.8 (Total)	ug/L	< 0.1	< 1.7	< 0.1	< 0.1	< 1.7	< 0.1	< 1.7	< 0.1	< 0.1	< 8.6	< 8.6	< 8.6	< 8.6	<0.1	< 8.6	<0.1	<0.1	<0.1	< 8.6	< 8.6	< 8.6
1,1,2-Trichloroethane	16000	ug/L	< 0.1	< 1.7	< 0.1	< 0.1	< 1.7	< 0.1	< 1.7	< 0.1	< 0.1	< 8.6	< 8.6	< 8.6	< 8.6	<0.1	< 8.6	<0.1	<0.1	<0.1	< 8.6	< 8.6	< 8.6
Toluene	5900	ug/L	< 0.1	6.2	< 0.1	< 0.1	< 1.7	< 0.1	200	< 0.1	< 0.1	210	120	110	120	140	12	98	156	81	13	340	20
2-Hexanone	nv	ug/L	-	< 17	-	-	< 17	-	< 17	-	-	< 86	< 86	< 86	< 86	-	< 86	-	-	-	< 86	< 86	< 86
Chlorodibromomethane	50000	ug/L	< 0.1	< 1.7	< 0.1	< 0.1	< 1.7	< 0.1	< 1.7	< 0.1	< 0.1	< 8.6	< 8.6	< 8.6	< 8.6	<0.1	< 8.6	<0.1	<0.1	<0.1	< 8.6	< 8.6	< 8.6
1,2-Dibromomethane	nv	ug/L	< 0.1	< 1.7	< 0.1	< 0.1	< 1.7	< 0.1	< 1.7	< 0.1	< 0.1	< 8.6	< 8.6	< 8.6	< 8.6	<0.1	< 8.6	<0.1	<0.1	<0.1	< 8.6	< 8.6	< 8.6
Tetrachloroethene	5	ug/L	< 0.1	< 1.7	< 0.1	< 0.1	< 1.7	< 0.1	< 1.7	< 0.1	< 0.1	< 8.6	< 8.6	< 8.6	< 8.6	<0.1	< 8.6	<0.1	<0.1	<0.1	< 8.6	< 8.6	< 8.6
1,1,2,2-Tetrachloroethane	22	ug/L	< 0.1	< 1.7	< 0.1	< 0.1	< 1.7	< 0.1	< 1.7	< 0.1	< 0.1	< 8.6	< 8.6	< 8.6	< 8.6	<0.1	< 8.6	<0.1	<0.1	<0.1	< 8.6	< 8.6	< 8.6
Chlorobenzene	500	ug/L	< 0.1	< 1.7	< 0.1	< 0.1	8.1	< 0.1	4.4	< 0.1	< 0.1	< 8.6	< 8.6	< 8.6	< 8.6	<0.1	< 8.6	<0.1	<0.1	<0.1	< 8.6	< 8.6	38
Ethylbenzene	28000	ug/L	< 0.1	6	< 0.1	< 0.1	2.4	< 0.1	31	< 0.1	< 0.1	23	49	45	18	44	17	32	59	29	< 8.6	770	77
m + p Xylenes	5600 (Total)	ug/L	< 0.1	8.6	< 0.1	< 0.1	< 1.7	< 0.1	92	< 0.1	< 0.1	59	130	120	55	370	30	196	410	144	11	260	230
Bromoform	840	ug/L	< 0.1	< 1.7	< 0.1	< 0.1	< 1.7	< 0.1	< 1.7	< 0.1	< 0.1	< 8.6	< 8.6	< 8.6	< 8.6	<0.1	< 8.6	<0.1	<0.1	<0.1	< 8.6	< 8.6	< 8.6
Styrene	940	ug/L	< 0.1	1.8	< 0.1	< 0.1	< 1.7	< 0.1	7	< 0.1	< 0.1	10	16	14	< 8.6	<0.1	< 8.6	<0.1	<0.1	<0.1	13	31	16
o-Xylene	5600 (Total)	ug/L	< 0.1	9.2	< 0.1	< 0.1	< 1.7	< 0.1	36	< 0.1	< 0.1	45	69	64	35	138	23	84	220	70	69	150	82
1,3-Dichlorobenzene	7600	ug/L	< 0.1	< 1.7	< 0.1	< 0.1	< 1.7	< 0.1	< 1.7	< 0.1	< 0.1	< 8.6	< 8.6	< 8.6	< 8.6	<0.1	< 8.6	<0.1	<0.1	<0.1	< 8.6	< 8.6	< 8.6
1,4-Dichlorobenzene	7600	ug/L	< 0.1	< 1.7	< 0.1	< 0.1	4.5	< 0.1	3.6	< 0.1	< 0.1	< 8.6	47	40	< 8.6	<0.1	< 8.6	<0.1	<0.1	<0.1	22	< 8.6	12
1,2-Dichlorobenzene	7600	ug/L	< 0.1	< 1.7	< 0.1	< 0.1	< 1.7	< 0.1	2.8	< 0.1	< 0.1	< 8.6	< 8.6	< 8.6	< 8.6	<0.1	< 8.6	<0.1	<0.1	<0.1	< 8.6	< 8.6	< 8.6
Total Xylenes (calculated)	5600	ug/L	-	18	-	-	<3.4	-	130	-	-	100	200	180	90	-	53	-	-	-	80	410	310
1,1,1,2 Tetrachloroethane	6	ug/L	-	<1.7	-	-	<1.7	-	<1.7	-	-	<8.6	<8.6	<8.6	<8.6	-	<8.6	-	-	-	<8.6	<8.6	<8.6
Total Petroleum Hydrocarbons																							
TPH C6 - C10	nv	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TPH C10 - C24	nv	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TPH (Heavy Oil)	nv	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

NOTES "-" = not analysed, nv=no value , Dup = Duplicate sample

*1 = Ministry of the Environment, Guideline for Use at Contaminated Sites in Ontario Feb 1997. Surface soil criteria for all land uses for a non-potable groundwater condition, criteria for course grained soil

TABLE E-11 Con't
RENNIE STREET LANDFILL
LEACHATE ANALYTICAL RESULTS
VOLATILE ORGANIC COMPOUNDS (VOCs) and TOTAL PETROLEUM HYDROCARBONS (TPH)

		Sample Designation	MW6-49A	MW6-49B	MW6-49B	MW6-50	MW6-51A	MW6-51B	MW6-52A	MW6-52B	MW6-53A	MW6-53B	MW6-57	MW6-58A	MW6-58B	MW6-59	MW6-59	MW6-60	MW6-61	GW3	GW4	GW6	SP2
		Sample Date	May 11/00	May 12/00	May 12/00	May 11/00	May 18/00	May 17/00	May 17/00	May 17/00	May 17/00	May 17/00	June 21/00	July 13/00	July 12/00	July 12/00	July 12/00	July 12/00	July 12/00	June 21/00	June 21/00	June 21/00	May 18/00
Parameter	*1 MOE Table B Criteria	Units			Dup												Dup						
VOC'S																							
Chloromethane	nv	ug/L	<0.5	<0.5	<0.5	<0.5	<4.3	<4.2	<0.5	<2.2	<4.3	<4.3	<2.2	<0.5	<0.5	<4.3	<4.3	<0.5	<0.5	<2.2	<2.2	<0.5	<0.5
Vinyl Chloride	0.5	ug/L	<0.5	<0.5	<0.5	<0.5	<4.3	<4.2	<0.5	<2.2	<4.3	<4.3	<2.2	<0.5	<0.5	<4.3	<4.3	17	<0.5	<2.2	<2.2	<0.5	<0.5
Bromomethane	3.7	ug/L	<0.5	<0.5	<0.5	<0.5	<4.3	<4.2	<0.5	<2.2	<4.3	<4.3	<2.2	<0.5	<0.5	<4.3	<4.3	<0.5	<0.5	<2.2	<2.2	<0.5	<0.5
Chloroethane	nv	ug/L	<0.5	<0.5	<0.5	<0.5	<4.3	<4.2	<0.5	<2.2	<4.3	<4.3	<2.2	<0.5	<0.5	<4.3	<4.3	3.4	1.2	<2.2	<2.2	<0.5	<0.5
Trichlorofluoromethane	nv	ug/L	<0.3	<0.3	<0.3	<0.3	<2.6	<2.5	<0.3	<1.3	<2.6	<2.6	<1.3	<0.3	<0.3	<2.6	<2.6	<0.3	<0.3	<1.3	<0.3	<0.3	<0.3
Acetone	3300	ug/L	2	4	10	2	<17	<17	3	<9	<17	<17	<40	<10	<10	<17	<17	<10	<10	<50	<40	<10	3
1,1-Dichloroethene	0.66	ug/L	<0.2	<0.2	<0.2	<0.2	<1.7	<1.7	<0.2	<0.9	<1.7	<1.7	<0.9	<0.2	<0.2	<1.7	<1.7	2	<0.2	<0.9	<0.9	<0.2	<0.2
Dichloromethane	50000	ug/L	<1	<1	<1	<1	<9	<8	<1	<1	<1	<9	<4	<1	<1	<9	<9	<1	<1	<4	<4	<1	<1
t-1,2-Dichloroethene	100	ug/L	<0.2	<0.2	<0.2	<0.2	<1.7	<1.7	<0.2	<0.9	<1.7	<1.7	<0.9	<0.2	<0.2	<1.7	<1.7	1	<0.2	<0.9	<0.9	<0.2	<0.2
Methyl-t-butyl Ether(MTBE	50000	ug/L	<1	<1	<1	<1	<8.6	<8.3	<1	<4.3	<8.6	<8.6	<4.3	<1	<1	<8.6	<8.6	<1	<1	<4.3	<4.3	<1	<1
1,1-Dichloroethane	9000	ug/L	<0.2	<0.2	<0.2	<0.2	<1.7	<1.7	<0.2	<0.9	<1.7	<1.7	<0.9	<0.2	<0.2	<1.7	<1.7	2.2	8.6	<0.9	<0.9	<0.2	<0.2
Methyl Ethyl Ketone	50000	ug/L	<2	<2	<2	<2	<17	<17	<2	<9	<17	<17	<9	<2	<2	<17	<17	<2	<2	<9	<9	<2	<2
cis-1,2-Dichloroethylene	70	ug/L	<0.2	<0.2	<0.2	<0.2	<1.7	<1.7	<0.2	<0.9	<1.7	<1.7	<0.9	<0.2	<0.2	<1.7	<1.7	250	0.4	<0.9	<0.9	<0.2	<0.2
Chlorobromomethane	nv	ug/L	<0.2	<0.2	<0.2	<0.2	<1.7	<1.7	<0.2	<0.9	<1.7	<1.7	<0.9	<0.2	<0.2	<1.7	<1.7	<0.2	<0.2	<0.9	<0.9	<0.2	<0.2
Chloroform	430	ug/L	<0.2	1.6	1.5	<0.2	<1.7	<1.7	<0.2	<0.9	<1.7	<1.7	<0.9	<0.2	0.4	<1.7	<1.7	0.3	<0.2	<0.9	<0.9	<0.2	<0.2
1,2-Dichloroethane	17	ug/L	<0.2	<0.2	<0.2	<0.2	<1.7	<1.7	<0.2	<0.9	<1.7	<1.7	<0.9	<0.2	<0.2	13	13	<0.2	<0.2	<0.9	<0.9	<0.2	<0.2
1,1,1-Trichloroethane	200	ug/L	<0.2	<0.2	<0.2	<0.2	<1.7	<1.7	<0.2	<0.9	<1.7	<1.7	<0.9	<0.2	<0.2	<1.7	<1.7	1.4	1.5	<0.9	<0.9	<0.2	<0.2
Carbon Tetrachloride	17	ug/L	<0.2	<0.2	<0.2	<0.2	<1.7	<1.7	<0.2	<0.9	<1.7	<1.7	<0.9	<0.2	<0.2	<1.7	<1.7	<0.2	<0.2	<0.9	<0.9	<0.2	<0.2
Benzene	1900	ug/L	<0.2	<0.2	<0.2	<0.2	<1.7	7.8	<0.2	<0.9	<1.7	<1.7	4.2	<0.2	<0.2	260	260	0.4	0.9	<0.9	<0.9	0.8	<0.2
1,2-Dichloropropane	9.3	ug/L	<0.2	<0.2	<0.2	<0.2	<1.7	<1.7	<0.2	<0.9	<1.7	<1.7	<0.9	<0.2	<0.2	<1.7	<1.7	<0.2	<0.2	<0.9	<0.9	<0.2	<0.2
Trichloroethene	50	ug/L	<0.2	<0.2	<0.2	<0.2	<1.7	<1.7	<0.2	<0.9	<1.7	<1.7	<0.9	<0.2	<0.2	<1.7	<1.7	250	0.6	<0.9	<0.9	<0.2	<0.2
Bromodichloromethane	50000	ug/L	<0.2	0.4	0.3	<0.2	<1.7	<1.7	<0.2	<0.9	<1.7	<1.7	<0.9	<0.2	<0.2	<1.7	<1.7	<0.2	<0.2	<0.9	<0.9	<0.2	<0.2
cis-1,3-Dichloropropene	3.8 (Total)	ug/L	<0.5	<0.5	<0.5	<0.5	<4.3	<4.2	<0.5	<2.2	<4.3	<4.3	<2.2	<0.5	<0.5	<4.3	<4.3	<0.5	<0.5	<2.2	<2.2	<0.5	<0.5
Methyl Isobutyl Ketone	50000	ug/L	<2	<2	<2	<2	<17	<17	<2	<9	<17	<17	<9	<2	<2	<17	<17	<2	<2	<9	<9	<2	<2
t-1,3-Dichloropropene	3.8 (Total)	ug/L	<0.2	<0.2	<0.2	<0.2	<1.7	<1.7	<0.2	<0.9	<1.7	<1.7	<0.9	<0.2	<0.2	<1.7	<1.7	<0.2	<0.2	<0.9	<0.9	<0.2	<0.2
1,1,2-Trichloroethane	16000	ug/L	<0.2	<0.2	<0.2	<0.2	<1.7	<1.7	<0.2	<0.9	<1.7	<1.7	<0.9	<0.2	<0.2	<1.7	<1.7	0.7	<0.2	<0.9	<0.9	<0.2	<0.2
Toluene	5900	ug/L	<0.2	<0.2	<0.2	<0.2	<1.7	<1.7	<0.2	0.9	<1.7	<1.7	1.2	0.3	<0.2	5.6	5.7	0.4	1.2	<0.9	1.1	0.5	<0.2
2-Hexanone	nv	ug/L	<2	<2	<2	<2	<17	<17	<2	<8.6	<17	<17	<8.6	<2	<2	<17	<17	<2	<2	<8.6	<8.6	<2	<2
Chlorodibromomethane	50000	ug/L	<0.2	<0.2	<0.2	<0.2	<1.7	<1.7	<0.2	<0.9	<1.7	<1.7	<0.9	<0.2	<0.2	<1.7	<1.7	<0.2	<0.2	<0.9	<0.9	<0.2	<0.2
1,2-Dibromomethane	nv	ug/L	<0.2	<0.2	<0.2	<0.2	<1.7	<1.7	<0.2	<0.9	<1.7	<1.7	<0.9	<0.2	<0.2	<1.7	<1.7	<0.2	<0.2	<0.9	<0.9	<0.2	<0.2
Tetrachloroethene	5	ug/L	<0.2	<0.2	<0.2	<0.2	<1.7	<1.7	<0.2	<0.9	<1.7	<1.7	<0.9	<0.2	<0.2	<1.7	<1.7	<0.2	<0.2	<0.9	<0.9	<0.2	<0.2
1,1,2,2-Tetrachloroethane	22	ug/L	<0.2	<0.2	<0.2	<0.2	<1.7	<1.7	<0.2	<0.9	<1.7	<1.7	<0.9	<0.2	<0.2	<1.7	<1.7	<0.2	<0.2	<0.9	<0.9	<0.2	<0.2
Chlorobenzene	500	ug/L	<0.2	<0.2	<0.2	<0.2	<1.7	<1.7	<0.2	<0.9	<1.7	<1.7	77	<0.2	<0.2	9.6	9.6	0.5	<0.2	<0.9	<0.9	1.4	<0.2
Ethylbenzene	28000	ug/L	<0.2	<0.2	<0.2	<0.2	<1.7	<1.7	<0.2	<0.9	<1.7	<1.7	7.3	<0.2	<0.2	13	12	<0.2	2.1	<0.9	<0.9	<0.2	<0.2
m + p Xylenes	5600 (Total)	ug/L	<0.2	<0.2	<0.2	<0.2	<1.7	<1.7	<0.2	<0.9	<1.7	<1.7	3.7	<0.2	<0.2	3.2	3	<0.2	1.1	<0.9	<0.9	<0.2	<0.2
Bromoform	840	ug/L	<0.2	<0.2	<0.2	<0.2	<1.7	<1.7	<0.2	<0.9	<1.7	<1.7	<0.9	<0.2	<0.2	<1.7	<1.7	<0.2	<0.2	<0.9	<0.9	<0.2	<0.2
Styrene	940	ug/L	<0.2	<0.2	<0.2	<0.2	<1.7	<1.7	<0.2	<0.9	<1.7	<1.7	<0.9	<0.2	<0.2	<1.7	<1.7	<0.2	<0.2	<0.9	<0.9	<0.2	<0.2
o-Xylene	5600 (Total)	ug/L	<0.2	<0.2	<0.2	<0.2	<1.7	<1.7	<0.2	<0.9	<1.7	<1.7	1.1	<0.2	<0.2	2.7	2.7	<0.2	0.7	<0.9	<0.9	<0.2	<0.2
1,3-Dichlorobenzene	7600	ug/L	<0.2	<0.2	<0.2	<0.2	<1.7	<1.7	<0.2	<0.9	<1.7	<1.7	5.3	<0.2	<0.2	<1.7	<1.7	<0.2	<0.2	<0.9	<0.9	<0.2	<0.2
1,4-Dichlorobenzene	7600	ug/L	<0.2	<0.2	<0.2	0.2	<1.7	<1.7	<0.2	<0.9	<1.7	<1.7	23	0.3	<0.2	9.8	9.9	0.4	0.4	<0.9	<0.9	1	<0.2
1,2-Dichlorobenzene	7600	ug/L	<0.2	<0.2	<0.2	<0.2	<1.7	<1.7	<0.2	<0.9	<1.7	<1.7	0.9	<0.2	<0.2	<1.7	<1.7	<0.2	0.4	<0.9	<0.9	<0.2	<0.2
Total Xylenes (calculated)	5600	ug/L	<0.4	<0.4	<0.4	<0.4	<3.4	<3.4	<0.4	<1.8	<3.4	<3.4	4.8	nd	nd	5.9	5.7	nd	1.8	nd	nd	nd	<0.4
1,1,1,2 Tetrachloroethane	6	ug/L	<0.2	<0.2	<0.2	<0.2	<1.7	<1.7	<0.2	<0.9	<1.7	<1.7	<0.9	<0.2	<0.2	<1.7	<1.7	<0.2	<0.2	<0.9	<0.9	<0.2	<0.2
Total Petroleum Hydrocarbons																							
TPH C6 - C10	nv	mg/L	-	-	-	-	-	-	-	-	-	-	0.70	-	<0.01	0.16	0.21	-	-	-	0.03	0.01	
TPH C10 - C24	nv	mg/L	-	-	-	-	-	-	-	-	-	-	0.5	-	<0.2	<0.2	<0.2	-	-	-	<0.2	<0.2	
TPH (Heavy Oil)	nv	mg/L	-	-	-	-	-	-	-	-	-	-	<1	-	<1	<1	<1	-	-	-	<1	<1	

NOTES "-" = not analysed, nv=no value , Dup = Duplicate sample

*1 = Ministry of the Environment Guideline for Use at Contaminated Sites in Ontario Feb 1997, Surface soil criteria for all land uses for a non-potable groundwater condition, criteria for course grained soil

Table E-12
RENNIE STREET LANDFILL
LEACHATE ANALYTICAL RESULTS
POLYCHLORINATED BIPHENYLS (PCBs)

Sample Location	Sample Date	*1 MOE Table B Groundwater	Units	PCB Concentration ug/L
MW6-11	Oct 21/97	0.2	ug/L	<0.1
	May 9/00	0.2	ug/L	0.4
MW6-12	Oct 21/97	0.2	ug/L	<0.1
	Oct 21/97(Dup)	0.2	ug/L	0.06
MW6-13	Oct 21/97	0.2	ug/L	<0.1
	May 9/00	0.2	ug/L	0.1
MW6-14A	Oct 21/97	0.2	ug/L	18
	Oct 21/97(Dup)	0.2	ug/L	124
	Apr 27/98	0.2	ug/L	23
MW6-15	Oct 21/97	0.2	ug/L	9
	Oct 21/97(Dup)	0.2	ug/L	2
MW6-21	Feb 12/99	0.2	ug/L	1.2
MW6-21	May 10/00	0.2	ug/L	6.5
MW6-22	Apr 27/98	0.2	ug/L	18
MW6-23	Apr 27/98	0.2	ug/L	4
	May 10/00	0.2	ug/L	2.9
	May 10/00(Dup)	0.2	ug/L	3.5
MW6-24	Apr 27/98	0.2	ug/L	19
MW6-25	Apr 27/98	0.2	ug/L	12
	May 10/00	0.2	ug/L	21
MW6-28	Apr 27/98	0.2	ug/L	4
MW6-42	Oct 13/98	0.2	ug/L	<1
	May 10/00	0.2	ug/L	0.38
MW6-43	Oct 13/98	0.2	ug/L	<1
	Oct 13/98(Dup)	0.2	ug/L	<1
MW6-44	Oct 13/98	0.2	ug/L	1.3
MW6-47	May 11/00	0.2	ug/L	6.4
MW6-48	May 11/00	0.2	ug/L	3.5
MW6-49A	May 11/00	0.2	ug/L	0.18
MW6-49B	May 12/00	0.2	ug/L	0.03
	May 12/00(Dup)	0.2	ug/L	<0.02
MW6-50	May 11/00	0.2	ug/L	<0.02
MW6-51A	May 18/00	0.2	ug/L	0.34
MW6-51B	May 17/00	0.2	ug/L	0.07
MW6-52A	May 17/00	0.2	ug/L	0.59
MW6-52B	May 17/00	0.2	ug/L	<0.02
MW6-53A	May 17/00	0.2	ug/L	<0.02
MW6-53B	May 17/00	0.2	ug/L	<0.02
MW6-57	June 21/00	0.2	ug/L	230
MW6-58A	July 13/00	0.2	ug/L	<0.02
MW6-58B	July 12/00	0.2	ug/L	<0.02
MW6-59	July 12/00	0.2	ug/L	0.11
MW6-59	July 12/00(Dup)	0.2	ug/L	0.14
MW6-60	July 12/00	0.2	ug/L	<0.02
MW6-61	July 12/00	0.2	ug/L	0.06
GW3	June 21/00	0.2	ug/L	<0.02
GW4	June 21/00	0.2	ug/L	<0.02
GW6	June 21/00	0.2	ug/L	<0.02

NOTES:

*1 = Ministry of the Environment, Gideline for use at Contaminated Sites in Ontario, Feb 1997: Surface soil criteria for all land uses for a non potable groundwater condition, criteria for course grained soil

Dup = Duplicate sample

TABLE E-13
RENNIE STREET LANDFILL
LEACHATE ANALYTICAL RESULTS
POLYCYCLIC AROMATIC HYDROCARBONS (PAH)

		Sample location / Date	MW6-11 May 9/00	MW6-12 May 9/00	MW6-13 May 9/00	MW6-59 July 12/00	MW6-59 July 12/00	GW6 June 26/00
Parameter	*1 MOE Table B Criteria	Units					Dup	
PAH								
Naphthalene	5900	ug/L	4.09	4.17	28.3	2.01	1.76	< 0.2
Acenaphthylene	2000	ug/L	< 0.5	0.07	0.03	<0.5	<0.5	< 0.2
Acenaphthene	1700	ug/L	0.4	0.41	1.48	0.164	0.183	0.2
Fluorene	290	ug/L	0.38	0.46	1.05	0.146	0.141	0.4
Phenanthrene	63	ug/L	1.08	0.89	1.38	0.258	0.172	0.3
Anthracene	12	ug/L	0.27	0.09	1.34	<0.5	<0.5	< 0.2
Fluoranthene	130	ug/L	0.73	0.29	0.34	0.120	0.037	< 0.2
Pyrene	40	ug/L	0.67	0.2	0.24	0.093	0.024	< 0.2
Benz(a)Anthracene	5	ug/L	0.09	0.04	< 0.01	0.037	<0.1	< 0.2
Chrysene	3	ug/L	0.11	0.07	< 0.01	0.047	<0.1	< 0.2
Benzo(a)Pyrene	1.9	ug/L	0.12	0.03	0.05	0.033	<0.1	< 0.2
Indeno(1,2,3-cd)Pyrene	0.27	ug/L	0.05	0.02	0.03	0.021	<.1	< 0.2
Dibenzo(a,h)Anthracene	0.25	ug/L	< 0.1	< 0.01	< 0.01	<0.1	<0.1	< 0.2
Benzo(g,h,i)Perylene	0.2	ug/L	0.1	0.02	0.03	0.024	<0.1	< 0.2
1-Methylnaphthalene	13000*	ug/L	0.32	1.01	2.11	0.599	0.630	0.2
2-Methylnaphthalene	13000*	ug/L	0.48	1.3	3.2	0.583	0.539	< 0.2
Benzo(b)Fluoranthene	7	ug/L	0.1	0.34	0.05	0.033	<0.1	< 0.2
Benzo(k)Fluoranthene	0.4	ug/L	0.11	0.04	0.06	0.030	<0.1	< 0.2

NOTES:
*1 = Ministry of the Environment, Gideline for use at Contaminated Sites in Ontario, Feb 1997: Surface soil criteria for all land uses for a non potable groundwater condition, criteria for course grained soil
* (1-,2- methyl napthalene) - the sum of both can not exceed 13000
Dup = Duplicate sample

Table E-15
Surface Water Analytical Results - VOCs, PCBs and TPH Parameters
Rennie St. Landfill, Hamilton, Ontario

			Seep water											Outfalls						Surface water			
		Sample Location	S2	S2	S4	S8	S9	S12	S14	S15	S17	S19	S20	P1	P2	P3	P3	P4	P9(SW6)	SW1	SW1	SW5	SW5
		Sample Date	Nov 20/98	May 4/00	May 4/00	May 4/00	May 4/00	May 4/00	May 4/00	May 4/00	May 4/00	Mar 15/00	Mar 15/00	Oct 13/98	Mar [illegible]/00	Mar 21/00	Oct [illegible]/98	Oct 13/98	May 8/00	Oct [illegible]/98	May 8/00	Oct [illegible]/98	May 8/00
Parameter	PWQO Criteria	Units																					
Volatile Organic Compounds																							
Chloromethane	700	ug/L	-	< 4.3	< 2.2	< 4.3	< 4.3	< 2.2	< 2.2	< 2.2	< 2.2	<4.3	<4.3	<0.1	< 0.5	< 0.5	<0.1	<0.1	< 0.5	<0.1		<0.1	
Vinyl Chloride	600	ug/L	-	< 4.3	< 2.2	< 4.3	< 4.3	< 2.2	< 2.2	< 2.2	< 2.2	<4.3	<4.3	<0.1	< 0.5	< 0.5	<0.1	<0.1	< 0.5	<0.1		<0.1	
Bromomethane	0.9	ug/L	-	< 4.3	< 2.2	< 4.3	< 4.3	< 2.2	< 2.2	< 2.2	< 2.2	<4.3	<4.3	<0.1	< 0.5	< 0.5	<0.1	<0.1	< 0.5	<0.1		<0.1	
Chloroethane	nv	ug/L	-	< 4.3	< 2.2	< 4.3	< 4.3	< 2.2	< 2.2	< 2.2	< 2.2	<4.3	<4.3	-	< 0.5	< 0.5	-	-	< 0.5	-	-		
Trichlorofluoromethane	nv	ug/L	-	< 2.6	< 1.3	< 2.6	< 2.6	< 1.3	< 1.3	< 1.3	< 1.3	<2.6	<2.6	<0.1	< 0.3	< 0.3	<0.1	<0.1	< 0.3	<0.1		<0.1	
Acetone	nv	ug/L	-	25	10	160	23	14	16	54	13	<17	<17	-	< 2	< 2	-	-	2	-			
1,1-Dichloroethylene	40	ug/L	-	< 1.7	< 0.9	< 1.7	< 1.7	< 0.9	< 0.9	< 0.9	< 0.9	<1.7	<1.7	<0.1	< 0.2	< 0.2	<0.1	<0.1	< 0.2	<0.1		<0.1	
Dichloromethane (Methylene Chloride)	100	ug/L	-	< 9	< 4	< 9	< 9	< 4	< 4	< 4	< 4	<9	<9	<0.1	< 1	< 1	<0.1	<0.1	< 1	<0.1	-	<0.1	
trans-1,2-Dichloroethylene	200 (Total)	ug/L	-	< 1.7	< 0.9	< 1.7	< 1.7	< 0.9	< 0.9	< 0.9	< 0.9	<17	<17	<0.1	< 0.2	< 0.2	<0.1	<0.1	< 0.2	<0.1		<0.1	
Methyl-t-butyl Ether (MTBE)	200	ug/L	-	< 8.6	< 4.3	< 8.6	< 8.6	< 4.3	< 4.3	< 4.3	< 4.3	<8.6	<8.6	-	< 1	< 1	-	-	< 1				
1,1-Dichloroethane	200	ug/L	-	< 1.7	< 0.9	< 1.7	< 1.7	< 0.9	< 0.9	< 0.9	< 0.9	<1.7	<1.7	<0.1	< 0.2	< 0.2	<0.1	<0.1	< 0.2	<0.1		<0.1	-
Methyl Ethyl Ketone (MEK)	400	ug/L	-	< 17	< 9	37	< 17	< 9	< 9	< 9	< 9	<17	<17	-	< 2	< 2	-	-	< 2	-			
cis-1,2-Dichloroethylene	200 (Total)	ug/L	-	< 1.7	< 0.9	< 1.7	< 1.7	< 0.9	< 0.9	< 0.9	< 0.9	<1.7	<1.7	-	< 0.2	< 0.2	-	-	0.4	-			
Chlorobromomethane	nv	ug/L	-	< 1.7	< 0.9	< 1.7	< 1.7	< 0.9	< 0.9	< 0.9	< 0.9	<1.7	<1.7	-	< 0.2	< 0.2	-	-	< 0.2		-		
Chloroform	nv	ug/L	-	< 1.7	< 0.9	< 1.7	< 1.7	< 0.9	< 0.9	< 0.9	< 0.9	<1.7	<1.7	<0.1	2.9	< 0.2	<0.1	<0.1	< 0.2	<0.1	-	<0.1	
1,2-Dichloroethane	100	ug/L	-	< 1.7	< 0.9	< 1.7	< 1.7	< 0.9	< 0.9	< 0.9	< 0.9	<1.7	<1.7	<0.1	< 0.2	< 0.2	<0.1	<0.1	< 0.2	<0.1	-	<0.1	
1,1,1,-Trichloroethane	10	ug/L	-	< 1.7	< 0.9	< 1.7	< 1.7	< 0.9	< 0.9	< 0.9	< 0.9	<1.7	<1.7	<0.1	< 0.2	< 0.2	<0.1	<0.1	< 0.2	<0.1		<0.1	-
Carbon Tetrachloride	nv	ug/L	-	< 1.7	< 0.9	< 1.7	< 1.7	< 0.9	< 0.9	< 0.9	< 0.9	<1.7	<1.7	<0.1	< 0.2	< 0.2	<0.1	<0.1	< 0.2	<0.1		<0.1	
Benzene	100	ug/L	11	< 1.7	1.5	21	11	2.2	1.8	3.2	< 0.9	1.9	13	<0.1	< 0.2	0.5	<0.1	<0.1	< 0.2	<0.1	<0.2	<0.1	<0.2
1,2-Dichloropropane	0.7	ug/L	-	< 1.7	< 0.9	< 1.7	< 1.7	< 0.9	< 0.9	< 0.9	< 0.9	<1.7	<1.7	<0.1	< 0.2	< 0.2	<0.1	<0.1	< 0.2	<0.1		<0.1	
Trichloroethylene	20	ug/L	-	< 1.7	< 0.9	< 1.7	< 1.7	< 0.9	< 0.9	< 0.9	< 0.9	<1.7	<1.7	<0.1	< 0.2	< 0.2	<0.1	<0.1	< 0.2	<0.1	-	<0.1	
Bromodichloromethane	200	ug/L	-	< 1.7	< 0.9	< 1.7	< 1.7	< 0.9	< 0.9	< 0.9	< 0.9	<1.7	<1.7	<0.1	3.2	< 0.2	<0.1	<0.1	< 0.2	<0.1		<0.1	
cis-1,3-Dichloropropene	nv	ug/L	-	< 4.3	< 2.2	< 4.3	< 4.3	< 2.2	< 2.2	< 2.2	< 2.2	<4.3	<4.3	<0.1	< 0.5	< 0.5	<0.1	<0.1	< 0.5	<0.1		<0.1	
Methyl Isobutyl Ketone	nv	ug/L	-	< 17	< 9	< 17	< 17	< 9	< 9	< 9	< 9	<17	<17	-	< 2	< 2	-	-	< 2	-	-	-	
trans-1,3-Dichloropropene	7	ug/L	-	< 1.7	< 0.9	< 1.7	< 1.7	< 0.9	< 0.9	< 0.9	< 0.9	<1.7	<1.7	<0.1	< 0.2	< 0.2	<0.1	<0.1	< 0.2	<0.1		<0.1	
1,1,2-Trichloroethane	800	ug/L	-	< 1.7	< 0.9	< 1.7	< 1.7	< 0.9	< 0.9	< 0.9	< 0.9	<1.7	<1.7	<0.1	< 0.2	< 0.2	<0.1	<0.1	< 0.2	<0.1		<0.1	
Toluene	0.8	ug/L	9.9	< 1.7	0.9	< 1.7	< 1.7	< 0.9	2	3.6	< 0.9	<1.7	<1.7	<0.1	< 0.2	< 0.2	<0.1	<0.1	< 0.2	<0.1	<0.2	<0.1	<0.2
2-Hexanone	nv	ug/L	-	< 17	< 8.6	< 17	< 17	< 8.6	< 8.6	< 8.6	< 8.6	<17	<17	-	< 2	< 2	-	-	< 2		-		
Chlorodibromomethane	40	ug/L	-	< 1.7	< 0.9	< 1.7	< 1.7	< 0.9	< 0.9	< 0.9	< 0.9	<1.7	<1.7	<0.1	1.8	< 0.2	<0.1	<0.1	< 0.2	<0.1	-	<0.1	
1,2-Dibromoethane	nv	ug/L	-	< 1.7	< 0.9	< 1.7	< 1.7	< 0.9	< 0.9	< 0.9	< 0.9	<1.7	<1.7	-	< 0.2	< 0.2	-	-	< 0.2	-		-	
Tetrachloroethylene	50	ug/L	-	< 1.7	< 0.9	< 1.7	< 1.7	< 0.9	< 0.9	< 0.9	< 0.9	<1.7	<1.7	<0.1	< 0.2	< 0.2	<0.1	<0.1	< 0.2	<0.1		<0.1	
1,1,2,2-Tetrachloroethane	70	ug/L	-	3.8	< 0.9	< 1.7	< 1.7	< 0.9	< 0.9	1.7	2.6	<1.7	<1.7	<0.1	< 0.2	< 0.2	<0.1	<0.1	< 0.2	<0.1	-	<0.1	-
Chlorobenzene	15	ug/L	-	< 1.7	5.6	230	80	2.6	< 0.9	1.4	< 0.9	<1.7	32	<0.1	< 0.2	2	<0.1	<0.1	0.4	<0.1	-	<0.1	
Ethylbenzene	8	ug/L	58	2	1.9	77	< 1.7	< 0.9	4.1	5.2	< 0.9	2.2	3.5	<0.1	< 0.2	< 0.2	<0.1	<0.1	< 0.2	<0.1	<0.2	<0.1	<0.2
m- & p-Xylenes	30(p-), 2(m-)	ug/L	120	2.6	2.4	11	2.6	< 0.9	1.5	2.2	< 0.9	<1.7	3.3	<0.1	< 0.2	0.2	<0.1	<0.1	< 0.2	<0.1	<0.2	<0.1	<0.2
Bromoform	60	ug/L	-	< 1.7	< 0.9	< 1.7	< 1.7	< 0.9	< 0.9	< 0.9	< 0.9	<1.7	<1.7	<0.1	< 0.2	< 0.2	<0.1	<0.1	< 0.2	<0.1	-	<0.1	
Styrene	4	ug/L	21	1.8	1.7	1.7	3.3	< 0.9	< 0.9	1.5	< 0.9	<1.7	<1.7	<0.1	< 0.2	< 0.2	<0.1	<0.1	< 0.2	<0.1	<0.2	<0.1	<0.2
o-Xylene	40	ug/L	120	9.4	8.9	8.3	18	< 0.9	4.2	8	< 0.9	<1.7	6.2	<0.1	< 0.2	< 0.2	<0.1	<0.1	< 0.2	<0.1	<0.2	<0.1	<0.2
1,3-Dichlorobenzene	2.5	ug/L	-	10	6.5	8.6	5.9	< 0.9	< 0.9	< 0.9	< 0.9	<1.7	<1.7	<0.1	< 0.2	< 0.2	<0.1	<0.1	< 0.2	<0.1		<0.1	
1,4-Dichlorobenzene	4	ug/L	-	15	15	32	37	1.6	1.2	2.5	< 0.9	<1.7	20	<0.1	< 0.2	1.5	<0.1	<0.1	0.2	<0.1	-	<0.1	
1,2-Dichlorobenzene	2.5	ug/L	-	< 1.7	1.2	< 1.7	< 1.7	< 0.9	< 0.9	< 0.9	< 0.9	<1.7	2.0	<0.1	< 0.2	< 0.2	<0.1	<0.1	< 0.2	<0.1	-	<0.1	-
1,1,1,2-Tetrachloroethane	20	ug/L	-	<1.7	<0.9	<1.7	<1.7	<0.9	<0.9	<0.9	<0.9	<1.7	<1.7	-	<0.2	<0.2	-	-	<0.2	<0.1	-		
PCB	0.001	ug/L	14	26	300	1.8	0.81	0.12	0.02	0.03	<0.02	<0.04	0.85	<1	0.09	0.1	<1	<1	<0.02	<1	-	<1	
Total Petroleum Hydrocarbons																							
Purgable TPH <= C10	nv	mg/L	0.83	0.08	0.07	0.4	0.18	0.02	0.03	0.03	0.06	<0.01	0.02	-	<0.01	<0.01	-	-	<0.01		<0.01		<0.01
TPH C10-C24	nv	mg/L	2.6	1.6	1.6	1.5	0.5	0.8	<0.2	1	<0.2	-	-	-	0.5	<0.2	-	-	-		<0.2		<0.2
TPH - Hot (Heavy oil>C25)	nv	mg/L	< 1	<1	<1	<1	<1	<1	<1	<1	<1	-	-	-	6	<1	-	-	-	-	-	-	-

NOTES
"-" = not analysed
nv = no value
PWQO = Water Management Policies, Guidelines, Provincial Water Quality Objectives of the Ministry of Environment and Energy (PWQO) July 1994

Table E-14
Surface Water Analytical Results - Metals and General Parameters
Rennie St. Landfill, Hamilton, Ontario

Seep water				Seep water											Outfalls						Surface water			
		Sample Location		S2	S2	S4	S8	S9	S12	S14	S15	S17	S19	S20	P1	P2	P3	P3	P4	F9(SW6)	SW1	SW1	SW5	SW5
		Sample Designation		S2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		Sample Date		Nov 25/99	May 4/00	May 4/00	May 4/00	May 4/00	May 4/00	May 4/00	May 4/00	May 4/00	Mar 15/00	Mar 15/00	Oct 13/98	Mar 21/00	Mar 21/00	Oct 13/98	Oct 13/98	May 5/00	Oct 13/98	May 16/00	Oct 13/98	May 16/00
Parameter	EQL	PWQO Criteria	Units																					
Metals																								
Aluminum	0.01	015 - 0.075	mg/L	-	945	20.8	7.14	15.7	48	115	285	27.9	<0.05	<0.05	<0.03	0.962	<0.01	<0.03	<0.03	0.014	<0.03	0.043	<0.03	0.252
Antimony	0.01	0.02	mg/L	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.005	<0.005	-	<0.002	<0.002	-	-	<0.002	-	<0.002	-	<0.002
Arsenic	0.04	0.005	mg/L		0.85	<0.04	<0.04	<0.04	<0.04	0.07	0.14	<0.04	<0.02	<0.02	-	<0.002	<0.005	-	-	<0.02	-	<0.002	-	<0.002
Barium	0.005	nv	mg/L	-	19.6	0.47	1.12	1.54	1.95	2.82	6.88	0.54	1.56	1.01	0.91	0.04	0.369	0.02	0.02	0.463	0.01	0.061	0.02	0.061
Beryllium	0.02	011 - 1.1 *1	mg/L	-	0.1	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.01	<0.01	<0.01	<0.005	<0.005	<0.01	<0.01	0.001	<0.01	<0.001	<0.01	<0.001
Bismuth	0.02	nv	mg/L	-	0.03	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.01	<0.01	-	<0.002	<0.002	-	-	<0.002	-	<0.002	-	<0.002
Boron	0.01	0.2	mg/L	-	6.1	8.9	4.54	3.22	2.6	2.57	2.64	1.25	1.77	2.83	<0.01	0.04	0.61	<0.01	<0.01	0.94	<0.01	0.1	<0.01	0.1
Cadmium	0.002	001 - 0.0005	mg/L	-	0.102	<0.002	0.003	<0.002	0.003	0.005	0.008	<0.002	<0.001	<0.001	<0.01	0.0005	0.0001	<0.01	<0.01	<0.0001	<0.01	<0.0001	<0.01	<0.0001
Calcium	0.05	nv	mg/L	-	77.1	60.1	107	90.2	126	125	108	126	195	123	115.3	56.4	226	174.72	82.3	190	74.36	137	80.77	140
Chromium (Total)	0.1	0.0089 *2	mg/L	-	4.35	<0.1	<0.1	<0.1	0.1	0.68	0.47	<0.1	<0.05	<0.05	<0.01	0.005	<0.01	<0.01	<0.01	<0.05	<0.01	<0.01	<0.01	<0.01
Cobalt	0.001	0.0009	mg/L		0.951	0.03	0.011	0.017	0.045	0.126	0.233	0.024	0.002	0.008	<0.01	0.001	0.002	<0.01	<0.01	0.002	<0.01	<0.001	<0.01	<0.001
Copper	0.002	001 - 0.005	mg/L	-	6.58	0.246	0.077	0.114	0.225	0.274	0.601	0.074	<0.005	<0.005	<0.01	0.032	<0.002	<0.01	<0.01	0.002	<0.01	0.002	<0.01	0.003
Iron	0.02	0.3	mg/L	-	3290	38.1	61.8	90.7	124	248	669	47.5	2.80	<0.3	6.91	1.43	1.84	1.6	0.85	0.19	0.06	0.07	0.02	0.22
Lead	0.0005	001 - 0.005	mg/L	-	24.3	0.168	0.133	0.118	0.247	0.871	0.797	0.115	<0.005	<0.005	<0.01	0.0334	<0.0005	<0.01	<0.01	0.002	<0.01	<0.0005	<0.01	0.0012
Magnesium	0.02	nv	mg/L	-	129	88.5	128	111	115	118	130	85	111	125	108.3	13.3	110	99.07	28.92	84.1	19.55	37.5	17.78	37.9
Manganese	0.002	nv	mg/L	-	151	1.12	0.45	1.02	2.42	5.74	12.9	1.19	0.510	0.19	0.23	0.289	0.7	0.72	1.14	0.512	0.09	0.055	0.1	0.055
Mercury	0.1	0.2	ug/L	-	14.8	0.2	0.3	0.3	1.1	0.7	2.3	0.2	0.6	2.1	-	-	-	-	-	<0.1	-	<0.1	-	<0.1
Molybdenum	0.02	0.04	mg/L	-	0.08	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.01	<0.01	<0.01	0.003	0.002	<0.01	<0.01	0.002	<0.01	0.004	<0.01	0.004
Nickel	0.002	0.025	mg/L	-	2.6	0.11	<0.02	0.04	0.1	0.27	0.53	0.07	<0.01	<0.01	<0.01	0.006	<0.002	<0.01	<0.01	<0.002	<0.01	0.002	<0.01	0.002
Potassium	0.2	nv	mg/L	-	174	148	112	111	141	148	164	84.4	56.5	80.4	98.7	2.42	21.8	45.3	7.1	27	8.3	5.43	5.5	5.64
Selenium	0.04	0.1	mg/L	-	0.08	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.02	0.02	-	<0.002	<0.002	-	-	<0.02	-	0.002	-	0.003
Silver	0.00005	0.0001	mg/L	-	0.012	0.005	<0.002	<0.002	<0.002	0.005	0.003	0.003	<0.001	<0.001	<0.01	<0.0001	<0.0001	<0.01	<0.01	<0.0001	<0.01	<0.0001	<0.01	<0.0001
Sodium	0.5	nv	mg/L	-	1800	1620	2630	4650	5840	8510	9960	4490	4240	1940	5853	43.4	1250	1014	64.1	952	70.6	173	70.3	184
Strontium	0.005	nv	mg/L	-	19.7	1.08	1.9	1.96	2.07	2.72	3.91	1.11	2.22	1.32	1.76	0.396	1.95	1.29	0.45	1.77	1.35	1.89	<0.01	1.85
Thallium	0.001	0.0003	mg/L	-	0.009	<0.001	<0.001	<0.001	<0.001	<0.001	0.0018	<0.001	0.0005	<0.0005	<0.01	<0.0002	<0.0002	-	-	<0.0002	-	<0.0002	-	<0.0002
Tin	0.02	nv	mg/L	-	2.03	0.04	0.05	0.04	<0.02	<0.02	0.06	<0.02	<0.01	<0.01	-	<0.002	<0.002	-	-	0.002	-	<0.002	-	<0.002
Titanium	0.002	nv	mg/L	-	4.76	0.33	0.19	0.29	0.49	0.28	0.61	0.12	<0.05	<0.05	<0.01	0.044	<0.005	<0.01	<0.01	<0.005	<0.01	<0.005	<0.01	0.008
Uranium	0.0001	0.005	mg/L	-	0.055	0.004	<0.002	<0.002	0.003	0.008	0.009	0.017	0.0010	0.001	-	0.0005	0.0073	-	-	0.0013	-	0.0032	-	0.0031
Vanadium	0.002	0.006	mg/L	-	2.14	0.035	<0.01	0.035	0.086	0.199	0.489	0.044	<0.05	<0.005	<0.01	0.006	<0.005	<0.01	<0.01	<0.005	<0.01	0.003	<0.01	0.003
Zinc	0.002	0.02	mg/L		32.4	0.395	0.255	0.488	2.1	1.78	4.33	0.679	0.110	0.75	<0.01	0.167	0.074	<0.01	<0.01	0.005	<0.01	0.016	<0.01	0.015
Silicon		nv	mg/L	-	-	-	-	-	-	-	-	-	-	-	8.4	-	-	13.83	10.83	-	3.4	-	3.8	-
General Chemistry																								
pH (Field)		6.5 - 8.5	pH units	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.58	-	7.35
Conductivity (Field)		nv	uS/cm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1430	-	1430
Temperature (Field)		nv	Celcius	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13.2	-	13.5
C.O.D. Total	10	nv	mg/L			-	-	-	-	-	-	-	-	-	-	-	-	-	-	117	-	-	-	-
Cyanide, Total as CN	0.002	0.005	mg/L	-	-	0.01	0.019	-	-	0.029	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH Value (Lab)	0.1	6.5 - 8.5	pH units		7.8	8.1	7.77	7.77	7.8	7.49	7.49	7.81	7.36	7.51	7.25	7.47	7.44	7.25	7.09	7.82	7.25	8.25	7.4	8.23
Ammonia as N	0.05	02 (un-ionize	mg/L	-	409	532	414	344	221	204	260	27.6	62.0	204	19.7	0.14	31.3	17.6	3.14	5.04	0.4	<0.05	0.32	0.11
Nitrogen,T. Kjeldahl as N	0.05	nv	mg/L	-	626	592	424	412	293	242	463	39.1	85.2	205	21	0.49	31.1	11.5	16	20.4	17.9	0.48	4.2	0.39
Nitrate as N	0.1	nv	mg/L	-	91	14.6	2.64	0.48	9.75	0.9	0.6	6.62	1.30	0.36	-	0.41	0.42	-	-	19	-	2.29	-	2.29
Nitrite as N	0.02	nv	mg/L	-	0.04	130	0.47	0.13	0.51	0.09	0.08	0.32	0.39	0.12	-	<0.02	0.03	-	-	0.25	-	<0.02	-	0.02
Nitrate + Nitrite as N	0.1	nv	mg/L	-	91	144	3.11	0.61	10.3	0.99	0.68	6.94	1.69	0.48	<0.05	0.41	0.45	0.03	0.36	19.2	0.17	2.29	0.44	2.31
Carbon, Diss. Org. (DOC) as C	0.5	nv	mg/L	-	10800	705	398	540	702	3950	388	<100	41.9	71.1	-	3.3	11.5	-	-	33.3	-	3.4	-	3.2
Phosphorus, Total as P	0.002	0.01 - 0.03	mg/L	-	149	2.74	2.44	5.78	20.1	4.56	109	0.46	0.78	2.44	-	0.08	0.04	-	-	0.065	-	0.048	-	0.048
Phosphorus,Diss Orth as P	0.01	nv	mg/L		2.41	0.28	<0.01	0.04	<0.01	<0.01	0.02	0.04	<0.01	<0.01	-	0.02	<0.01	-	-	0.01	-	0.03	-	0.02
Conductivity (Lab)	1	nv	us/cm		11500	11400	14000	19400	26900	36400	42800	20000	18300	10900	-	530	6940	-	-	5560	-	1500	-	1530
Sulphate as SO4	2	nv	mg/L		56	165	18	10	16	107	41	362	60	40	26.5	31	143	8.2	83	123	104.6	212	101.5	227
Alkalinity CaCO3	1	25% decrea	mg/L	-	1940	2350	2510	1870	1310	1430	1540	1080	1060	1410	432	166	702	462	270.8	706	191.6	2	152	< 1
BOD5	2	nv	mg/L	-	409	211	48	171	34	30	115	65	-	-	-	-	-	-	-	9	-	232	-	230
Chloride as Cl	1	nv	mg/L	-	3270	2520	4220	6880	10200	13200	15900	6760	6940	3210	10175	59	2360	7423	112.7	1720	112.2	< 2	123	< 2
Colour	5	nv	TCU	-	348	473	177	142	125	128	142	72	94	78	-	< 5	16	-	-	29	-	281	-	283
Silica, Reactive as SiO2	0.02	nv	mg/L	-	21.2	13.7	25.6	19.4	17.4	18.2	19	10.1	19.9	22.4	-	4.71	23.2	-	-	24.9	-	14	-	14
Calculated Hardness CaCO3		nv	mg/L	-	724	515	794	682	788	798	805	665	944	822	-	196	1020	-	-	821	-	5.77	-	5
Turbidity	0.1	10% increas	NTU	-	N.S.	N.S.	512	3860	377	416	4620	4960	214	100	-	79.1	13.8	-	-	8.21	-	497	-	506
Total Phenolics (4-AAP)	1	1	ug/L	-	25	44	37	34	16	25	24	4	-	-	<0.002	< 1	< 1	<0.002	<0.002	2	<0.002	1.9	<0.002	12.2
Bicarbonate as HCO3		nv	mg/L	-	1930	2320	2500	1860	1300	1430	1540	1070	1060	1410	-	166	700	-	-	702	-	< 1	-	1
Carbonate CO3		nv	mg/L	-	11	27	14	10	8	4	4	7	2	4	-	0	2	-	-	4	-	228	-	226

NOTES

"-" = not analysed
nv = no value
PWQO = Water Management Policies, Guidelines, Provincial Water Quality Objectives of the Ministry of Environment and Energy (PWQO) July 1994
N.S. = not suitable for analysis
*1 - Criteria is dependent on one or more of the following, pH, temperature and /or hardness
*2 - Criteria is for trivalent chromium. Criteria for hexavalent chromium is 0.001mg/L
nv = no value

Table E-17
Creek Bank Soil Analytical Results
Rennie Street Landfill, Hamilton, Ontario

Parameter	Criteria*1	Units	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S14
Sample Date			Nov 29/99	Nov 29/99	Nov 29/99	Nov 29/99	Nov 29/99	Nov 29/99	Dec 2/99	Mar 15/00	Mar 15/00	Mar 15/00	Mar 15/00	Dec 2/99	Mar 15/00	Dec 2/99	Mar 15/00
VOLATILE ORGANIC COMPOUNDS (BTEX)																	
Benzene	5300	ug/kg	< 71	< 1600	14	< 5	< 1100	< 5	-	< 5	< 5	< 5	< 5	-	< 5	-	< 5
Toluene	34000	ug/kg	< 71	< 1600	5	< 5	250000	< 5	-	< 5	< 5	< 5	< 5	-	< 5	-	< 5
Ethylbenzene	290000	ug/kg	< 71	< 1600	120	15	100000	< 5	-	< 5	< 5	< 5	< 5	-	< 5	-	< 5
m&p-Xylenes	34000(Total)	ug/kg	< 71	3400	88	25	36000	< 5	-	< 5	< 5	< 5	< 5	-	< 5	-	< 5
o-Xylene	34000(Total)	ug/kg	100	1700	190	37	14000	< 5	-	< 5	< 5	< 5	< 5	-	< 5	-	< 5
Styrene	1200	ug/kg	< 71	< 1600	22	7	2000	< 5	-	< 5	7	< 5	< 5	-	< 5	-	< 5
TOTAL PETROLEUM HYDROCARBONS																	
Purgable TPH <= C10	1000(Total)	ug/g	< 7	220	3	0 4	711	< 0.1	< 10	<0 1	<0 1	<0 1	<0 1	< 10	<0 1	< 10	<0 01
TPH C10-C24	1000(Total)	ug/g	2190	2660	257	434	5340	164	< 10	149	129	210	82	210	52	< 10	43
TPH - Heavy oil>C25	5000	ug/g	860	2120	798	538	6820	745	600	777	766	478	202	1500	432	260	118
PCB	25	ug/g	14	79	69	1500	34	0 92	14	12	0 79	0 11	1 2	0 14	0 56	< 0 05	0 11

NOTES:
"-"Not Analyzed
*1 Ministry of Environment, Guideline For Use At Contaminated Sites in Ontario, Feb 1997, Surface soil criteria for industrial/commercial land use for a non-potable groundwater condition, criteria for course grained soil

Table E-17 Con't
Creek Bank Soil Analytical Results
Rennie Street Landfill, Hailton, Ontario

Parameter	Criteria*1	Units	S15	S16	S17	S19	S18	S19	S20	S21	S22	S23	S24	S25	S26	S26	P1	P3
Sample Date			Mar 15/00	Dec 2/99	Dec 2-3/99	Oct 13/98	Dec 2-3/99	Dec 2-3/99	Mar 15/00	Mar 15/00	Apr 28/00	Apr 28/00	May 3/00	May 3/00	Oct 13/98	Jul 15/99	Oct 13/98	Oct 13/98
VOLATILE ORGANIC COMPOUNDS (BTEX)																		
Benzene	5300	ug/kg	< 5	-	< 5	-	< 5	-	9	<5	<40	<40	<5	<5	-	-	-	-
Toluene	34000	ug/kg	< 5	-	< 5	-	< 5	-	< 5	<5	190	<40	<5	<5	-	-	-	-
Ethylbenzene	290000	ug/kg	< 5	-	15	-	11	-	< 5	<5	590	<40	<5	<5	-	-	-	-
m&p-Xylenes	34000(Total)	ug/kg	< 5	-	6	-	7	-	< 5	<5	250	<40	<5	<5	-	-	-	-
o-Xylene	34000(Total)	ug/kg	< 5	-	14	-	12	-	6	<5	240	<40	<5	<5	-	-	-	-
Styrene	1200	ug/kg	< 5	-	< 5	-	< 5	-	<5	<5	<40	<40	<5	<5	-	-	-	-
TOTAL PETROLEUM HYDROCARBONS																		
Purgable TPH <= C10	1000(Total)	ug/g	<0 1	< 10	0 2	-	0 3	< 10	0 2	<0 1	5	<2	<0 1	<0 1	-	30	-	-
TPH C10-C24	1000(Total)	ug/g	57	< 10	< 40	-	80	160	350	94	460	160	83	126	-	2500	-	-
TPH - Heavy oil>C25	5000	ug/g	142	250	110	-	471	2500	2280	632	900	1,000	204	489	-	1350	-	-
PCB	25	ug/g	<0 05	0 1	< 0 05	<0 01	< 0 05	0 25	20	0 31	1 4	0 4	0 7	0 27	98 14	8 3	<0 01	<0 01

NOTES
"-" Not Analyzed
*1 Ministry of Environment, Guideline For Use At Contaminated Sites in Ontario, Feb 1997, Surface soil criteria for industrial/commercial land use for a non-potable groundwater condition, criteria for course grained soil

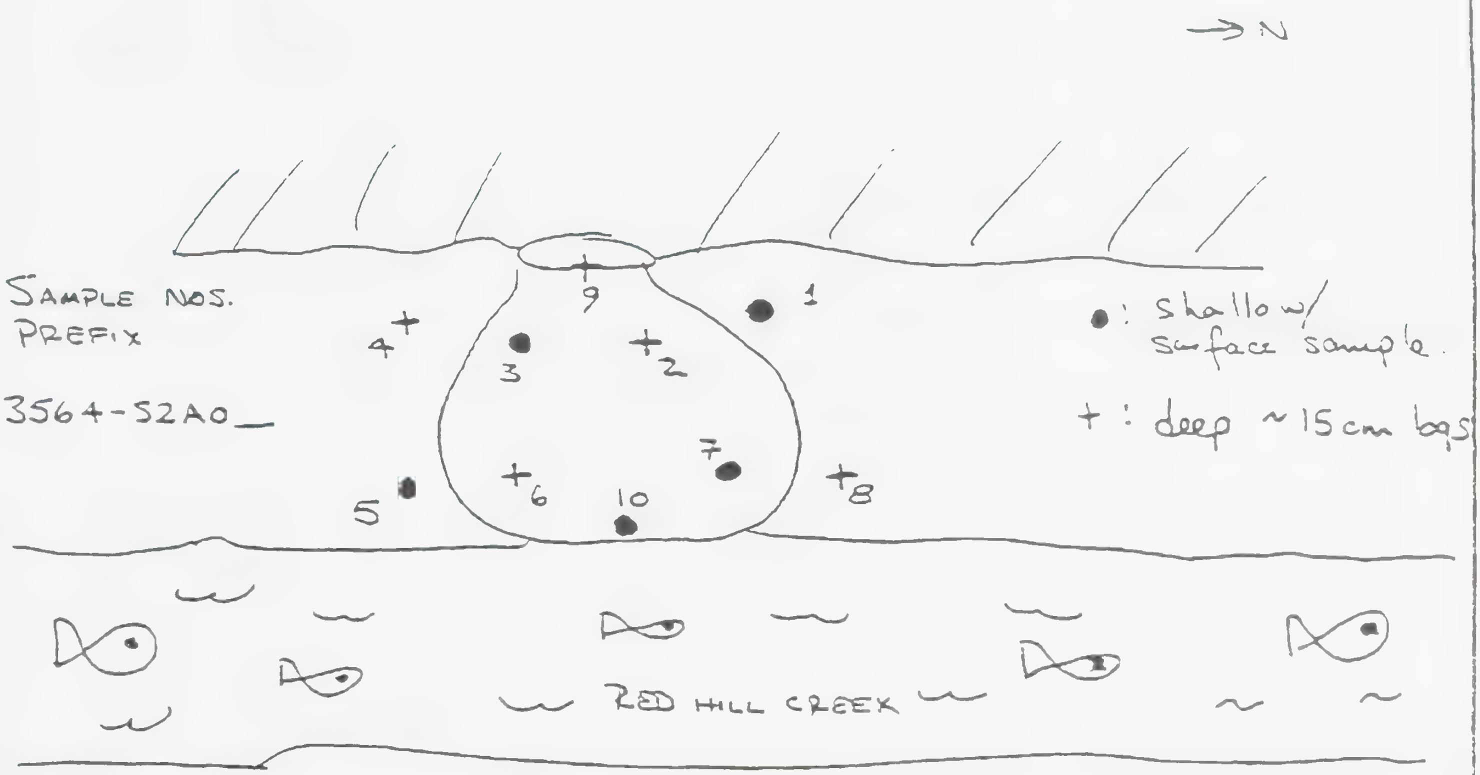
Table E-16
Surface Water Analytical Results
Rennie St. Landfill, Hamilton, Ontario

		Sample Location	S4	S8	S14
		Sample Designation	S4 11/05/00	S8 08/05/00	S14 08/05/00
		Date	May 11/00	May 8/00	May 8/00
Parameter	PWQO Criteria	Units			
Polychlorinated Aromatic Hydrocarbons (PAH)					
Naphthalene	7	ug/L	< 0.2	56	0.9
Acenaphthylene	nv	ug/L	< 0.05	< 0.05	0.08
Acenaphthene	nv	ug/L	< 0.05	1.37	0.21
Fluorene	0.2	ug/L	0.11	0.84	0.21
Phenanthrene	0.03	ug/L	0.12	0.52	0.09
Anthracene	0.0008	ug/L	< 0.05	0.13	< 0.05
Fluoranthene	0.0008	ug/L	0.1	0.05	0.02
Pyrene	nv	ug/L	0.09	0.04	0.02
Benz(a)anthracene	0.0004	ug/L	0.04	< 0.01	< 0.01
Chrysene	0.0001	ug/L	0.06	< 0.01	< 0.01
Benzo(a)Pyrene	nv	ug/L	0.04	< 0.01	< 0.01
Indeno(1,2,3-cd)Pyrene	nv	ug/L	0.04	< 0.01	< 0.01
Dibenzo(a,h)Anthracene	0.002	ug/L	0.01	< 0.01	< 0.01
Benzo(g,h,i)Perylene	0.00002	ug/L	0.04	< 0.01	< 0.01
1-Methylnaphthalene	2	ug/L	0.08	2.3	0.19
2-Methylnaphthalene	2	ug/L	< 0.05	3.2	0.36
Benzo(b)Fluoranthene	nv	ug/L	0.06	< 0.01	< 0.01
Benzo(k)Fluoranthene	0.0002	ug/L	0.04	< 0.01	< 0.01

NOTES:
nv = no value
PWQO = Water Management Policies, Guidelines, Provincial Water Quality Objectives of the Ministry of Environment and Energy (PWQO) July 1994

APPENDIX F

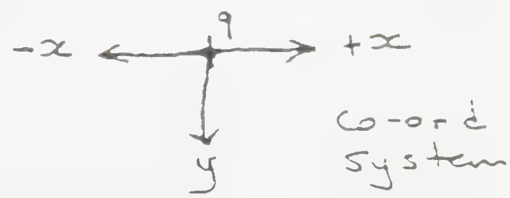
Detailed PCB Sampling and Remedial Investigations at S26



Sampling point 9: centre of area where seep emerges from bank

sampling point 10: at edge of Red Hill Creek

Distances from point 9 ⇒



Sampling Point	x (m)	y (m)
1	+1.00	0.5
2	+0.4	0.65
3	-0.25	0.5
4	-1.00	0.5
5	-0.80	1.75
6	-0.10	1.00
7	+0.20	1.75
8	+ 0.60	1.95
9	0	0
10	+ 0.40	3.20

By SLS Date 18/2/99 Project Name Red Hill Ck
Checked Date SEEP SAMPLING
Page 1 of 1 Project No 96-3564-27-08

PHILIP SERVICES

18-Feb-99

DILLON CONSULTING LIMITED
100 Sheppard Ave.,E, Suite 300
P.O. Box 1850, Station A
Toronto, ON
M2N 6N5

Page: 1
Copy: 1 of 2
Set : 1

Attn: Sean Salvatori
Project: 96-3564-27-08

Received: 11-Feb-99 17:01
PO #: 96-3564-27-08

Job: 9950835 Status: Final

Soil samples

Sample Id	PCB's GC/ECD ug/g	DCBP GC/ECD % Recovery
3564-S2A01	0.88	109. %
3564-S2A02	0.11	120. %
3564-S2A03	6.89	---
3564-S2A04	0.71	123. %
3564-S2A05	19.7	---
3564-S2A06	0.48	117. %
3564-S2A07	15.1	---
3564-S2A08	0.42	116. %
3564-S2A09	0.06	121. %
3564-S2A10	2.77	120. %
Blank	<0.05	108. %
QC Standard (found)	97.0%	98.0 %
QC Standard (expected)	100. %	100. %
Repeat 3564-S2A01	0.88	103. %

PHILIP SERVICES

18-Feb-99

DILLON CONSULTING LIMITED
100 Sheppard Ave.,E, Suite 300
P.O. Box 1850, Station A
Toronto, ON
M2N 6N5

Attn: Sean Salvatori
Project: 96-3564-27-08

Received: 11-Feb-99 17:01
PO #: 96-3564-27-08

Job: 9950835 Status: Final

- DCBP = Decachlorobiphenyl (surrogate standard for PCB's)
- The PCB's detected in all samples is Aroclor 1260.
- Surrogate recoveries are not reported for samples requiring dilutions

All work recorded herein has been done in accordance with normal professional standards using accepted testing methodologies and QA/QC procedures. Philip Analytical is limited in liability to the actual cost of the pertinent analyses done unless otherwise agreed upon by contractual arrangement. Your samples will be retained by PASC for a period of 30 days following reporting or as per specific contractual arrangements.

Job approved by:

Signed: M. Riskallah

Medhat Riskallah, Ph.D., C.Chem.
Manager, Gas Chromatography Section

APPENDIX G

Slope Stabilty Evaluation
Peto McCallum Ltd.

Peto MacCallum Ltd.
CONSULTING ENGINEERS

March 29, 2000

PML Ref: 99HF004

RECEIVED MAR 30 2000

Ms. Patsey D. Duever, M.A.Sc.
Dillon Consulting Limited
1425 Bishop Street
Cambridge, Ontario
N1R 6J9

Dear Ms. Duever

Slope Stability Evaluation
West Slope of Redhill Creek
North of Rennie Street
<u>Hamilton, Ontario</u>

We have conducted a visual examination of the east slope of the Rennie Street Landfill as requested. The site walk was conducted on March 23, 2000. We make the following comments concerning the stability of the fill slope:

i) The toe of the east slope of the Rennie Street Landfill coincides with the Redhill Creek.

ii) The slope is typically 10.0 to 11.5m high.

The inclination of the slope varies significantly over the length and height of the landfill. The inclination of the upper portion varies from 30 to 40° to the horizontal and is steepest near the south limit of the land fill where it is on the outside of a meander in the creek. The lower portion of the slope has been oversteepened by creek erosion; the resultant inclination of this section of the slope ranges from near vertical 50 to 60° to the horizontal. The height of the oversteepened lower section of the slope is 4 to 5 m at the south end of the landfill, reducing to about 1.5 m at the north end.

An approximate 3 m high, 15 m wide "berm" currently exists adjacent to the crest of the landfill slope.

iii) The slope is typically vegetated with long grass, young trees and shrubs (primarily grass) in the south part.

...2

45 Burford Road, Hamilton, Ontario L9E 3C6
Tel (905) 561-2231 Fax: (905) 561-6363
E-mail hami@petomac.on.ca

iv) Rubble consisting of large concrete slabs, asphaltic concrete, and the occasional steel bar in a silty sand/sandy silt matrix was observed on the face of the slope. It appears from exposures on the east slope of the creek valley that shale bedrock exists at the base of the creek. It is likely that this is a "skin" placed to retain the landfill material.

v) Seepage emanating onto the face of the slope was observed at numerous locations 1.5 to 3.0 m above the toe of slope. The seepage zones are somewhat localized in the south half and almost continuous in the northern part of the landfill.

vi) No evidence of deep-seated movement affecting the overall slope was detected during the site walk. Evidence of relatively shallow slumping of the surficial soil over most of the slope height was noted at several locations. It appears to result from pedestrian traffic.

The oversteepened section at the base of the slope appears to be regressing due to weathering effects, creek erosion and seepage onto the slope face. This distress is relatively shallow (50 to 100 mm), results from surficial material spalling from the slope face and appears to be occurring at a relatively slow rate.

A local approximate 20 m wide area of irregular topography was noted at the base of the slope, at the "drainage gulley" in the north central part of the landfill which could indicate possible previous instability.

It appears from these site observations and our experience on similar projects that the future performance of the slope will primarily be governed by:

a) the rate of regression of the lower part of the slope due to creek erosion.

b) seepage that emanates on the slope face.

c) the thickness of the rubble material on the face of the slope.

The apparent heavy pedestrian traffic also contributes to degradation of the slope stability.

We believe that an adequate margin of safety against deep seated movement exists at present. However, the stability of the slope is likely to decrease with time due to continued undercutting of the base of the slope by the creek that causes the toe to regress and the height of the oversteepened section to increase. A major slide could occur if the rubble that is apparent on the slope face is "breached" by regression at the base of the slope. Consequently, it is strongly recommended that measures are implemented to:

- prevent further regression of the toe of slope by creek erosion.
- support the toe of slope to resist the destabilizing forces that could initiate instability.

We trust this brief letter is sufficient and look forward to any questions you may have.

Sincerely

Peto MacCallum Ltd.

Dennis W. Kerr, M.Eng., P.Eng.
Manager Geotechnical and
Geo-Environmental Services
Hamilton

DWK:mma

2 cc: Dillon Consulting Limited
2 cc: Regional Municipality of Hamilton-Wentworth; G. Moore, P.Eng.

APPENDIX H

Stream Erosion Assessment
Water Regime and Simulations Ltd.

WATER REGIME
Investigations & Simulations Ltd.

WATER REGIME INVESTIGATIONS AND SIMULATIONS LTD.
P.O. BOX 28040, Parkdale Postal Outlet
Waterloo, Ontario, Canada, N2L 6J8
Phone: (519) 884-5816
FAX: (519) 884-8851

April 27, 2000

Patsy Deuver,
M.M Dillion Ltd.
1425 Bishop Street,
Cambridge, Ontario, N1R 6J9

Dear Patsy,

Re: Red Hill Creek - Stream Erosion Assessment along the Rennie St. Landfill
WRIS Project Reference Number: 99-001

Water Regime Investigations and Simulations Ltd has been retained as a sub-consultant to Dillon Consulting for the City of Hamilton on issues related to stream bank erosion in the vicinity of the Rennie St. Landfill and related contaminant leachate concerns along Red Hill Creek. The information provide in this letter summarizes the historical characteristics of Red Hill Creek in the vicinity of the landfill, existing stream dynamics, and provides a summary of various potential options that may be considered as part of the remediation scheme for this area in the context of mitigating stream erosion.

A morphometric analysis (time series air photo interpretation) was conducted on Red Hill Creek from the top of the escarpment down stream to discharge locations along Lake Ontario. Aerial photographs between the years of 1948 - 1993 were used to conduct this analysis. In addition, geological and survey maps (dating back to the 1800's) were also studied to provide further insight and interpretation into the historical state of Red Hill Creek. As can be interpreted from the existing mapping data, the reach of stream north (down stream) of the C.N.R. railway used to be estuarian environment with a broad flood plain and multiple threaded (braided) channels discharging at times to either Hamilton Harbor or Lake Ontario directly. As development ensued within the city and the Red Hill Creek valley, encroachment of the existing estuary (flood plain) increased to form a less sinuous and highly entrenched channel that exists today.

A site inspection was conducted on April 11, 2000 to examine the causes of stream bank erosion along the aforementioned reach. The hydraulic characteristics of Red Hill Creek are somewhat different in the vicinity of the landfill, relative to further reaches upstream. Between Barton St. and the C.N.R. railway, the channel hydraulics of Red Hill Creek begin to experience the backwater effects of Lake Ontario water levels. As a result, the sediment deposition characteristics and related grain sizes change. The mean particle (d_{50}) size changes decreases from a medium gravel (24mm) to medium - fine sand. Moreover, at discharges lower than bankfull, the mean channel velocity decreases, relative to up-stream reaches as the backwater effects begin to influence the channel hydraulics.

Although there are apparent geo-technical issues related to slope stability along both banks of Red Hill Creek

down stream of the C.N.R., one of the dominant causes of stream bank erosion (particularly along the western stream bank where the Rennie St. and Brampton St. lanfill's are located) is from channel incisesment. Essentially, incised channels are cross-sections which have vertical or nearly vertical stream banks. Therefore, as discharge increases, velocity proportionately increases and so too does near bank shear stress, the principle cause of stream bank erosion. Unlike streams with flood plains where once above the bankfull flow, the mean channel velocity decreases for a given series of flows, the velocity and related near bank shear stresses continue to rise in incised channels. This continued increase in shear velocity and shear stress causes a disproportionately high rate of bank erosion relative to upstream areas (where flood plains exist). It is without question that one of the principle causes of existing and continued stream bank erosion along this reach is from encroachment of the previous estuarian environment to the present cross-sectional form.

If the current cross-sectional form of Red Hill Creek is maintained in perpetuity down stream of the C.N.R., it should be expected that stream bank erosion will continue for very long period of time (100's - 1000's of years). If the natural river processes are left unattended, the evolutionary trend of the creek in this area, through bank scour and deposition, will be to develop a flood plain (approximately 0.75 m above the existing water level) and somewhere typically between 3 - 10 times the existing width of the stream. Stream bank erosion will be most dominant on the outsides of bends where near bank shear stress is the highest. And, as observed from the site inspection on the above noted date, approximately 1/3 of the length of the Rennie St. landfill (and a similar length on the Brampton St. Landfill) abuts against the out side bend of the creek.

An erosion analysis was also undertaken along the reach between CNR and Windermere basin. From a visual inspection and an erosion index inventory, the following erosion rates and sediment loadings to the creek were determined:

Table 1 Existing erosion of Red Hill Creek down stream of CNR.

Existing centre line along proposed works	609m				
Existing erosion rates along stream	Very Low	Low	Medium	High	Very High
Linear Distance (m)	260	380	346	232	0
Percent of net creek length	21%	31%	28%	19%	0%
Calibrated Erosion rate (m/year)	0.01	0.03	0.145	0.35	0.83
Mean Bank elevations (m)	0.85	0.85	1.5	2	3
Material Density (kg/m^3)	1920	1920	1920	1920	1920
Annual Sediment Loading to Creek	4243.2	18604.8	144489.6	311808	0

The annual cumulative sediment loading to Red Hill Creek along this reach from Table 1 is approximately 479,000 kg. For a watercourse of this encisement and proximity within the watershed, this yearly loading is typical (bing in the same order of magnitude) of other streams studied in southern Ontario.

Several remediation strategies are available to mitigate stream bank erosion and are all a function of construction cost, life expectancy, maintenance and, potential for fish habitat. The following is a summary of various options:

i) In-place bank lining - this approach uses either gabion baskets, armour stone or a similar construction material to build a vertical (or stable profile) wall along the outer bank of the existing stream foot print in the areas of concern to mitigate stream bank erosion. Typically, the life expectancy of these structures is between 10 - 40 years. However, because of the backwater effects and the increased susceptibility to form anchor ice along the emplaced

material, the life expectancy of these structures may be reduced by as much as a factor of two.

This scenario requires the excavation of material along the toe and behind the proposed structure to construct the wall up to a required elevation to produce a stable cross-sectional profile (i.e. excavation of landfill material). These structures provide minimal energy dissipation which result in the transfer of stream energy to further down stream areas. Typically, this results in higher rates of erosion and sediment loading to the stream beyond the limits of the construction. Moreover, the construction of a vertical wall only exacerbates the process of stream channel erosion by increasing the entrenchment of the channel. This usually results in increased stream bank erosion on the opposite bank of the channel and increases the rates of head cutting along the bed of the stream. As a result, the toe of structures are often undermined decreasing the life expectancy of the structures.

This scenario also destroys fish habitat along the banks of the stream and eliminates tree cover on the associated bank (although re-vegetation of the banks would take place). There is minimal variation in the longitudinal profile (i.e. absence of pools and riffles) using this construction method and hence very little change in hydraulic conditions which may generate turbulent flow and increase local aeration of the stream.

ii) this option is similar to the above option with the exception that it moves the bank lining approximately 1 - 3m to the east into the existing channel to mitigate localized stream bank erosion. The retaining wall is constructed to a stable slope however the net width of the stream is decreased. This option would likely reduce construction costs since the landfill material to be excavated and disposed of would be minimized. However, this scenario further decreases the width of the stream (increasing channel incision) and increases near bank shear stress. As a result, the opposite bank of the stream will likely begin to erode at a significantly higher rate to compensate for the works on th outside of the bend. Moreover, similar to option (i), dissipation of stream energy through the bank remediation area would be reduced leading to increased rates of bank erosion in down stream areas. The life expectancy would be similar to that of option (i) and may be shorter since the entrenchment of the stream would be increased further.

The construction of a retaining wall would also be a destruction of fish habitat and there would be an approximate 20% complete loss in habitat through this reach. Moreover, all of the vegetation on the western bank of the stream would be lost through the construction (although re-vegetation of the banks would take place).

iii) a third option is to line the entire channel with concrete. This would eliminate all concerns with respect to bank erosion, however, this would be a complete destruction of fish habitat. However, because this section of the stream is within the backwater hydraulics of Lake Ontario, it is a natural deposition zone. Therefore, regardless of what the lining of the channel would be, substrate would continue to be deposited in this area and cover up the lining. Thus over time, habitat would be restored within the bed of the stream and the habitat would be re-established. However, any groundwater linkages to the stream would be lost.

The capital cost of this option would be very high, relative to the other alternatives. Moreover, landfill material would still have to be excavated along the western limit of the stream and disposed of. Also, vegetation would be lost on both banks of the stream and up to the top of the bank on the side of the Rennie St. landfill. Also this approach would be in contradiction to the Red Hill Creek watershed plan [1998] which advocates the reduction of concrete within the watercourses.

iv) another option is to emulate (although limit) the natural tendencies of the river. For encised channels to be recovered to a stable cross-sectional profile in perpetuity, a stable cross-sectional profile must be developed. This is often done by filling in the existing channel to an elevation whereby the cross-sectional profile can be obtained. However, in the case of the study area (being at the bottom end of the watershed), this approach is not possible. The other typical endpoint is the excavation of the existing fill and / or bank material down to the existing bankfull channel elevation to produce a stable cross-sectional profile.

Currently, Red Hill Creek in the vicinity of the Rennie St. landfill has a bankfull width of 16.5m, with a small intermittent flood plain ranging between 2m - 5m. (i.e. net valley bottom width of 18.5 - 21.5m). Under a flood plain excavation scenario, the bankfull width of the channel could be reduced to 13.4m, however a net32m wide flood plain is required (as sketched in Figure 1). This would require approximately 12m - 15m of excavation at the base valley elevation (plus accounting for stable side slopes) to produce a stable cross-sectional profile.

The meander pattern of the stream could be shifted approximately 5m-10m to the east such that a flood plain bench could be created along the western bank of the stream and a stable 2.5:1 slope along the landfill. Moreover, along the western bank of the newly constructed flood plain bench, rock veins (see the attached schematic as Figure 2) could be installed to mitigate near bank shear stress and eliminate bank erosion. These structures have been used very effectively along the outsides of bends to mitigate erosion on various stream gradients and geological media. This construction approach would eliminate the need for the excavation of landfill material. Moreover, these structures provide a diversity in hydraulic conditions an changes in stream bed elevations which increase the local myriad of fisheries habitat states, hydraulic conditions (increased aeration) relative to the existing conditions.

However, to achieve this stable cross-sectional profile, as mentioned above, approximately 12m - 15m of flood plain will have to be developed on the east side of the existing channel from just down stream of the C.N.R. to a minimum of down stream of the Rennie St. Landfill. From the preliminary overview of data and land use, it is uncertain with respect to land ownership if this scenario is possible.

Although this scenario would provide a long term solution to maintain creek stability and is typically the lowest capital cost and long-term maintenance cost of all of the scenario mentioned, there would be a complete removal of all tress within the existing valley to achieve the stable profile. Although, re-forestation would occur to provide soil and stream bank stability, increase shading of the stream and aesthetic value, the re-growth would take several years until local thermal refuge would be possible within the stream.

Based upon a preliminary natural channel design (see Table 2 for design parameters) of the channel within the area of concern; which also includes a portion of the down-stream area to ensure that down-stream erosion is mitigated, the following results were obtained:

A net bankfull centre line stream length of 598m would be constructed. The present bankfull centre line length is 609m. Therefore, there would be a net channel length reduction of 2%.

Eight rock veins (Figure 2) and one cross vein (Figure 3) would be constructed along the channel length to mitigate near bank shear stress on the outsides of bends. Moreover, the construction of these structures would provide a greater diversity in hydraulic and habitat niches relative to the existing stream.

Based upon measured values of stream bank erosion from in-stream structures, a near bank shear stress analysis and sediment loading analysis, the net yearly sediment loading to the stream would be significantly reduced to approximately 1000 kg/year. This would be of significant benefit to Windermere basin, compared to current 479,000 kg/year, reducing the rate of in-filling of the wetland and reducing the frequency of dredging. This solution would also be consistent with the Red Hill Creek watershed plan [1998], where the document identified that long-term reductions in sediment loading to Windermere Basin was watershed goal.

The alternatives that we have outlined summarize a variety of approaches that I have been involved with and aware of for bank remediation. After you have had the opportunity to review this summary and combine it with other information relevant to this issue I will be more than happy to provide you with any further assistance you require. Please note, however, this assessment was based upon a very preliminary site inspection. If any of the above works are considered further in the future, additional works may be required to formulate a complete interpretation, plan and design.

If you have any further questions about this project or other matters please feel free to contact me at any time.

Sincerely,

Bill Annable M.Sc. (Eng), M.Sc., B.E.S., B.Sc.
WRIS

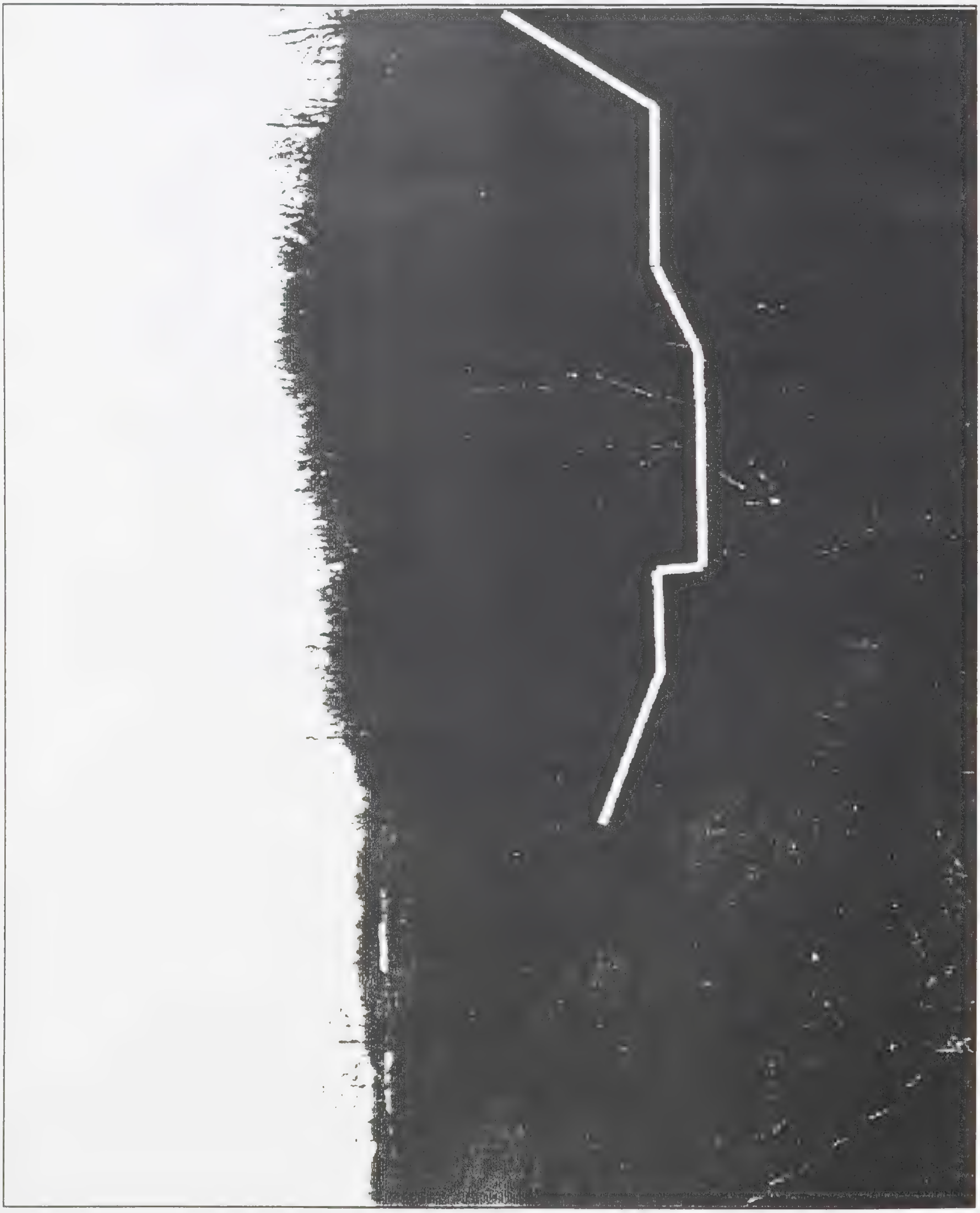
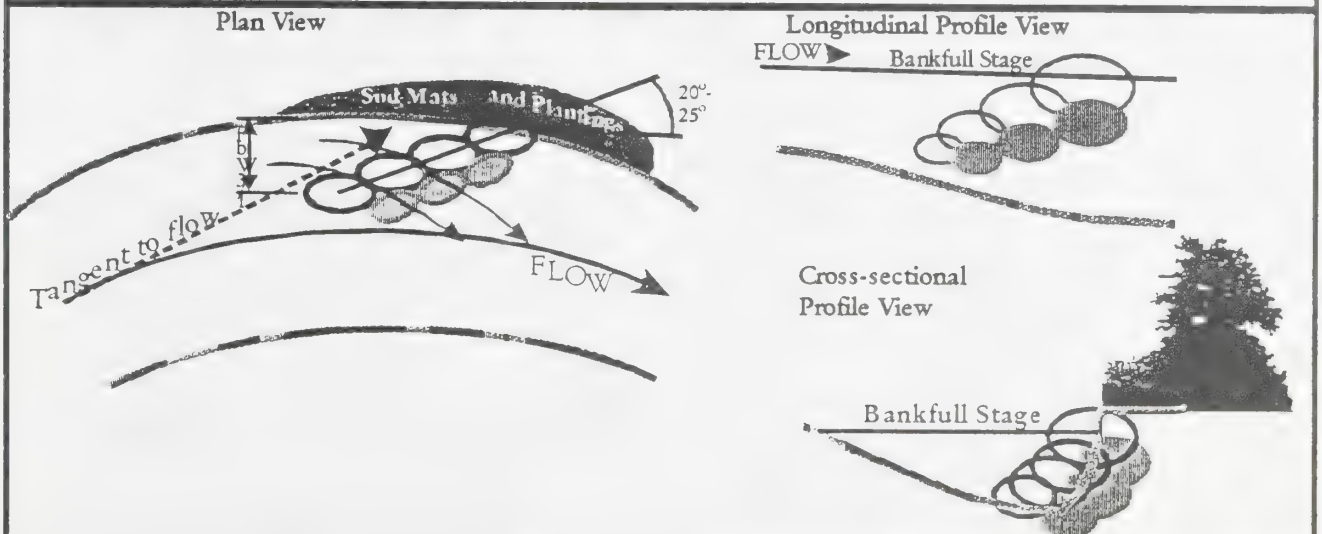


Figure 1. Schematic rendering of stable cross-sectional profile

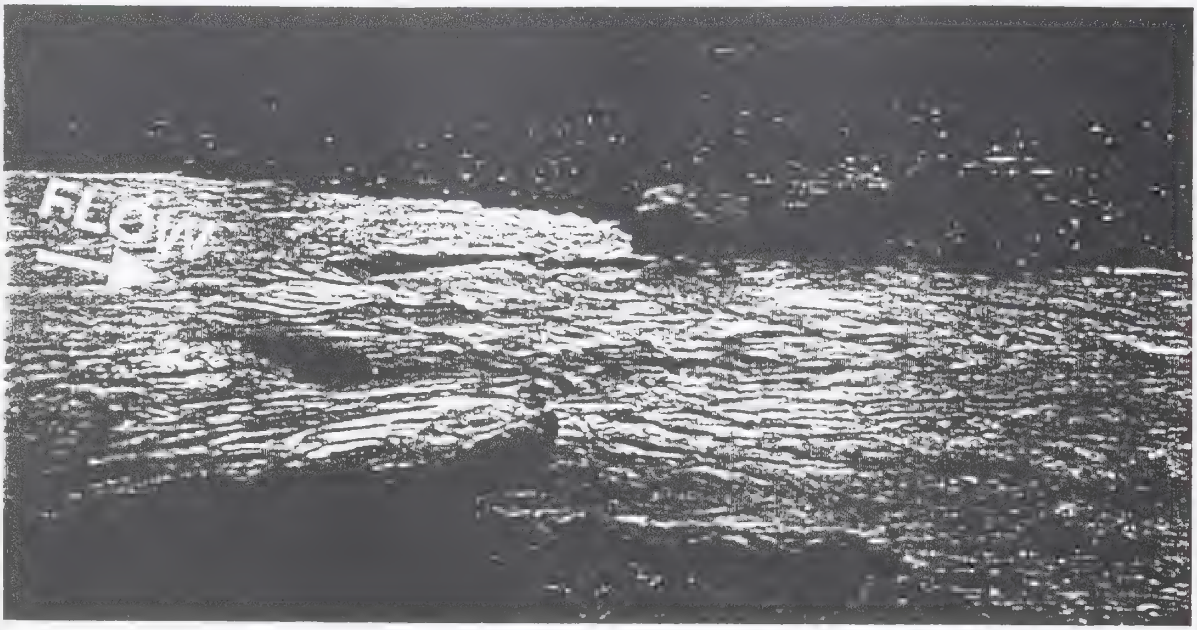
ROCK VEIN

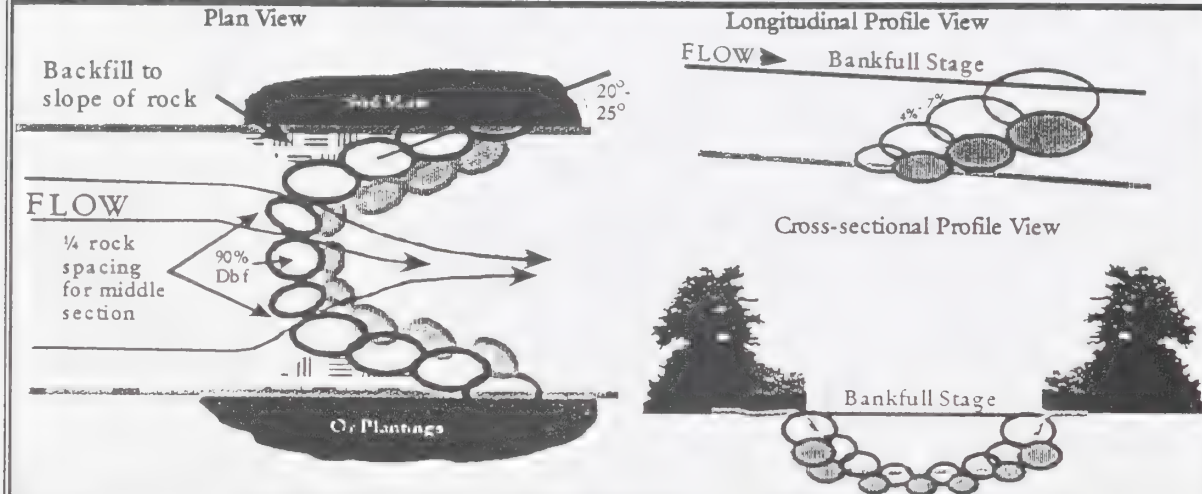


Purpose:	Reduce / offset erosion on ouside of bends
Placement:	Outside of bends, 1/4 channel width down stream of tangent to mean flow direction
Erosion Rates:	Monitored erosion rates <0.01m/year - typically immeasurable
Physical Method:	Reduciton of near bank shear stress by local reversal in water surface profile gradient and momentum transfer to central portion of channel
Vegetative control:	Placement of sod mats and/or shrubs on ouside of bank. Preferably inhiitory species to minimize pedestrian or grazing traffic.
Fish Habitat:	Quiescent water up-stream of structure with a high variability in flows (low and high flow) over the structure. Pool depths down-stream range between 2-4 bankfull depths.
Reynolds Number Range:	Re = 50 through 2000+
Froude Number Range:	Sub-critical through super critical flow

Figure 2. Rock vein structure schematic

CROSS VEIN





Purpose:	Grade control and enhancement of sediment routing
Placement:	Top end of riffles an / or 1/2 channel width up-stream of bridge structures
Erosion Rates:	Monitored erosion rates <0.01m/year - typically immeasurable
Physical Method:	Convergence of flow towards central portion of channel. Energy momentum transfer through local near bank reversal in gradient towards central portion of channel
Vegetative control:	Placement of sod mats on both banks. Added rooting mass stability can be achieved by the use of shrub and / or sedge species.
Fish Habitat:	Quiescent water up-stream along banks. Large distribution in velocites over structures with down stream pool depths ranging between 1.5 - 3 bankfull depths.range between 2-4 bankfull depths.
Reynolds Number Range:	Re = 50 through 4000+
Froude Number Range:	Sub-critical through super critical flow

Figure 3 Cross vein structure schematic

Table 2 Detailed design parameters of Red Hill Creek down stream of CNR

Discharge (m^3/s)	*16*		
Target Velocity (m/s)	*1.25*		
Area (m^2)	*12.80*		
Width:depth ratio	*14.0*		
Width (m)	*13.4*		
Depth (m)	0.96		
Sinuosity	1.15		
	Lowest	Max	slope
Bankfull channel slope	*0.00020*	0.00050	
Largest Point Bar Particle (Figure 41) (mm)	50	75	
Critical Shear (lb/ft^2) From Figure 40	0.028	0.028	
Critical Depth (m)	*4.72*	*6.42*	
Shear Stress (lb/ft^2)	0.096	0.106	
Radius of Curvature (m)	Low	Mean	High
Typical Range as a function of bankfull width	*2.50*	*2.75*	*3.00*
Typical radii of curvature from width range (m)	33	37	40
From Annable [1995b] - Existing Conditions (m)	22	27	32
Radius of Curvature [Annable, 1996]	33	36	38
DETAILED DESIGN RANGE	*29*	*33*	*37*
Meander Wave Length (m)	Low	Mean	High
Typical Range as a function of bankfull width	*10*	*12*	*14*
Typical meander wave length from width range (m)	134	161	187
From Annable [1995b] - Existing Conditions (m)	114	135	156
Meander Wave Length (m) Annable [1996] (m)	107	129	151
DETAILED DESIGN RANGE	*118*	*142*	*165*
Meander Apmplitude (m)	Low	Mean	High
Typical Range as a function of bankfull width	2.50	3.50	4.50
Typical meander amplitude from width range (m)	33	47	60
From Annable [1995b] - Existing Conditions (m)	30	35	40
From Annable [1996] (m)	27	34	41
DETAILED DESIGN RANGE	*30*	*39*	*47*
Pool Slope (m/m)	Low	Mean	High
Typical range as a function of bankfull slope	0.18	0.20	0.22
DETAILED DESIGN RANGE	*0.00004*	*0.00004*	*0.00004*
Pool Depth (m)	Low	Mean	High
Typical range as a function of bankfull depth	2.50	3.00	3.50
Pool Depth from the range related to bankfull depth	2.39	2.87	3.35
Existing Conditions	0.95	1.25	2.80
DETAILED DESIGN RANGE	*2.39*	*2.87*	*3.35*

Table 2 Cont.. - Detailed design parameters of Red Hill Creek down stream of CNR

Pool Width (m)	Low	Mean	High
Typical range as a function of bankfull width	1.30	1.50	1.70
Existing Conditions	9.7	18.4	22.3
DETAILED DESIGN RANGE	*1.3*	*1.5*	*1.7*
Riffle Slope (m/m)	Low	Mean	High
Typcial slope range as a function of bankfull slope	1.50	1.75	2.00
Riffle slope as a function of bankfull slope range	0.00030	0.00035	0.00040
Riffle Slope (m/m) - Annable [1996]	0.00058	0.00063	0.00068
From Annable [1995b] - Existing Conditions (m)	0.00100	0.00440	0.00680
DETAILED DESIGN RANGE	*0.00044*	*0.00049*	*0.00054*
Riffle max depth (m)	Low	Mean	High
Typical range as a function of bankfull depth	1.20	1.30	1.40
Typical max. riffle depth from bankfull depth	1.15	1.24	1.34
Existing Conditions	0.74	1.04	1.38
DETAILED DESIGN RANGE	*1.15*	*1.24*	*1.34*
Riffle Length (m)	Low	Mean	High
Riffle Length (m) - Annable [1996]	15	18	20
Existing Conditions	5	23	31
DETAILED DESIGN RANGE	*10*	*20*	*26*
Run Slope (m/m)	Low	Mean	High
Typcial slope range as a function of bankfull slope	0.60	0.70	0.80
Run slope as a function of bankfull slope range	0.00012	0.00014	0.00016
DETAILED DESIGN RANGE	*0.00012*	*0.00014*	*0.00016*
Run Depth (m)	Low	Mean	High
Typical range as a function of bankfull depth	1.90	2.05	2.20
Typical run depth from bankfull depth range	1.8	2.0	2.1
DETAILED DESIGN RANGE	*1.8*	*2.0*	*2.1*
Glide Slope (m/m)	Low	Mean	High
Typical range as a function of bankfull slope	0.30	0.40	0.50
Typical glide slope from bankfull slope range	0.00006	0.00008	0.00010
DETAILED DESIGN RANGE	*0.00006*	*0.00008*	*0.00010*
Glide depth (m)	Low	Mean	High
Typical range as a function of bankfull depth	1.40	1.60	1.80
Typical glide depth from bankfull depth range	1.34	1.53	1.72
DETAILED DESIGN RANGE	*1.34*	*1.53*	*1.72*
Glide width (m)	Low	Mean	High
Typical range as a function of bankfull width	1.50	1.60	1.70
Glide width from bankfull width range	20	21	23
DETAILED DESIGN RANGE	*20*	*21*	*23*

APPENDIX I

Silt Fence and Boom Inspection / Maintenance Program

SILT FENCE AND BOOM INSPECTION/MAINTENANCE PROGRAM
FORMER RENNIE STREET LANDFILL

LOCATION:

Silt fences and absorbent booms along the west side of the Red Hill Creek between the CN Rail Embankment and the Brampton Street Foot bridge are to be visually inspected by walking along the west bank of the creek.

INSPECTION:

The Contractor is to provide personnel that have been trained to work at contaminated sites, have been informed of the known hazards associated with this site and who have the appropriate protective equipment.

Silt Fence

The inspector is to identify areas where the existing silt fence is damaged, bottom is not buried, or has been destroyed. If the damage is minor (stake knocked over, staple pulled loose or small area of soil washed out) the inspector is to replace stake, restaple, or rebury bottom of fence, as necessary. The inspector is to carry:

- stakes
- hammer
- shovel
- camera that records date and time
- appropriate personal safety equipment
- staple gun.

If areas of the fence are more extensively damaged or destroyed, the inspector is to record the damage, take a picture that clearly shows the "seep number" and complete the inspection

Absorbent Booms

Absorbent booms are to be visually inspected in conjunction with the silt fence inspection Booms that have been moved or disturbed are to be replaced or relocated as required by the inspector

Absorbent booms that have been removed, damaged or are saturated are to be replaced. Saturation can be identified when the liquid downstream of the boom contains an oily sheen Waste booms are to be stored in appropriately marked steel drums on-site in the drum storage area.

New Seeps

If the inspector observes any previously unidentified seeps, they should be staked and numbered and a plan for installation of a silt fence and absorbent booms identified.

REPORTING:

A daily log sheet (attached) is to be completed by the inspector. Identification of new seeps and major repairs, and documentation of minor repairs are to be included on the log sheet. Repairs are to be identified by seep number, which is marked on a stake adjacent to the seep. The Daily Logs are to be faxed to Peter Dunn (fax # 905-546-4473) on the day of the inspection.

If new seeps are observed or major repairs are required, the inspector is to complete a "work request" form (attached) and telephone the following people, in order, until contact is made.

1. Peter Dunn, Director of Waste Management
Region of Hamilton-Wentworth
35 King Street East, Main Floor
Hamilton, ON
L8N 4A9
Tel: 905-546-4409 (office)
905-973-4264 (cellular)
905-627-9509 (residence)
Fax 905-546-4473

2. Reg Meiers
City of Hamilton.
71 Main Street West,
City Hall, Department of Public Works
Hamilton, ON
L8P 4Y5
Tel: 905-546-4297 (office)
905-985-7148 (residence)
Fax: 905-546-3972

3 Patsy Duever
Dillon Consulting Limited
1425 Bishop Street
Cambridge, ON
N1R 6J9
Tel: 519-623-6761 (office)
519-577-4322 (cellular)
519-747-0403 (residence)
Fax: 519-623-8805

Once contact is made, instructions will be provided on where to fax the work request form for approval. Authorization for the contractor to proceed with the work will be by signing and returning, by fax, the work request form. If faxing is not possible, authorization can be verbal with the fax to be returned to the contractor as soon as possible. Copies of all work request forms will be faxed to Peter Dunn for filing.

Once the work request has been authorized, the contractor is to mobilize the necessary labour, materials and equipment to complete the work on the same day. In the event that weather conditions make the work unsafe to complete, the contractor is to complete the work as soon as conditions permit the safe execution of the work. Upon completion of the work, a photo of the repaired area is to be taken and the contractor's copy of the work request form is to be completed indicating time and date of completion of the work. The completed form is to be faxed to Peter Dunn and Dillon

Photographs are to be developed in duplicate and accurately labeled. One set of photographs are to be filed with the daily log sheets and work request forms in the contractor's office. The second set of photographs are to be similarly labeled and sent to Dillon on a monthly basis.

FREQUENCY OF MONITORING:

The Contractor's inspector is to complete the visual inspection of the silt fence and absorbent booms daily, seven days per week, prior to 9 AM. The frequency of monitoring may change depending upon conditions at the site. All changes in schedule will be provided, in writing, to the contractor.

DAILY LOG
SILT FENCE AND BOOM INSPECTION/MAINTENANCE PROGRAM
RENNIE STREET LANDFILL, HAMILTON, ONTARIO

Date ______________ Time Start ______________ Time Complete ___________

Temperature ____________________________ Weather _________________________

General Condition of Silt Fences and Absorbent Booms.

____
____
____
____
____

Areas requiring minor repairs (describe).

____
____
____
____
____
____
____

Have new seeps been identified? Yes ________ No _________

If yes, describe.

____
____
____

Are Major Repairs Required? Yes ________ No _________

If new seeps have been observed, or major repairs are required, fill out "work request" and forward for authorization.

Signature of Inspector ____

WORK REQUEST FORM
SILT FENCE AND BOOM INSPECTION/MAINTENANCE PROGRAM
RENNIE STREET LANDFILL, HAMILTON, ONTARIO

Date ______________________________

Time ______________________________

Inspector ______________________________

Contractor ______________________________

This form is to be used to identify major repairs to the silt fences and absorbent booms along the west side of the Red Hill Creek.

Silt Fence Repairs (describe nature and extent and reference to seep #).

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________
6. ______________________________

Absorbent Boom Repair and Replacement (describe reason for replacement and reference seep #)

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________
6. ______________________________

Inspector's Signature ______________________________

Authorization (Print Name) ______________________________

(Sign Name) ______________________________

COMPLETION

Date ______________________________

Time ______________________________

Inspector's Signature ______________________________

APPENDIX J

Display Boards for June 1, 2000 Public Information Session

WELCOME

Public Consultation Session

Remedial Works
Closed Rennie Street
and Brampton Street Landfills

June 1, 2000 / 6:00 pm - 9:00 pm

DILLON

WHY ARE WE HERE?

Remedial works are required at the closed Rennie Street and Brampton Street Landfills to prevent discharges of pollutants into Red Hill Creek. Both are old dump sites where there was uncontrolled dumping in the 1950s and 1960s. Contaminants are currently discharging from the landfills along the west bank of the creek.

The purpose of this public consultation session is to provide information on conditions at the site and to solicit input from the public on the proposed remedial works.

Questions?

Staff are here today to assist you. Please feel free to review the display boards and discuss any questions you have.

Comments?

We are interested in your point of view. Please write your comments on the sheet provided.

THE PROBLEM

- Leachate is generated in landfills through the mixing of rainwater, snowmelt and groundwater that flows into the landfill with liquid from the decomposing waste.

- The leachate is coming out of the landfills at locations along the west bank of Red Hill Creek. We call these localized flows seeps.

- The leachate has unacceptable concentrations of PCBs, petroleum hydrocarbons, ammonia and chlorides.

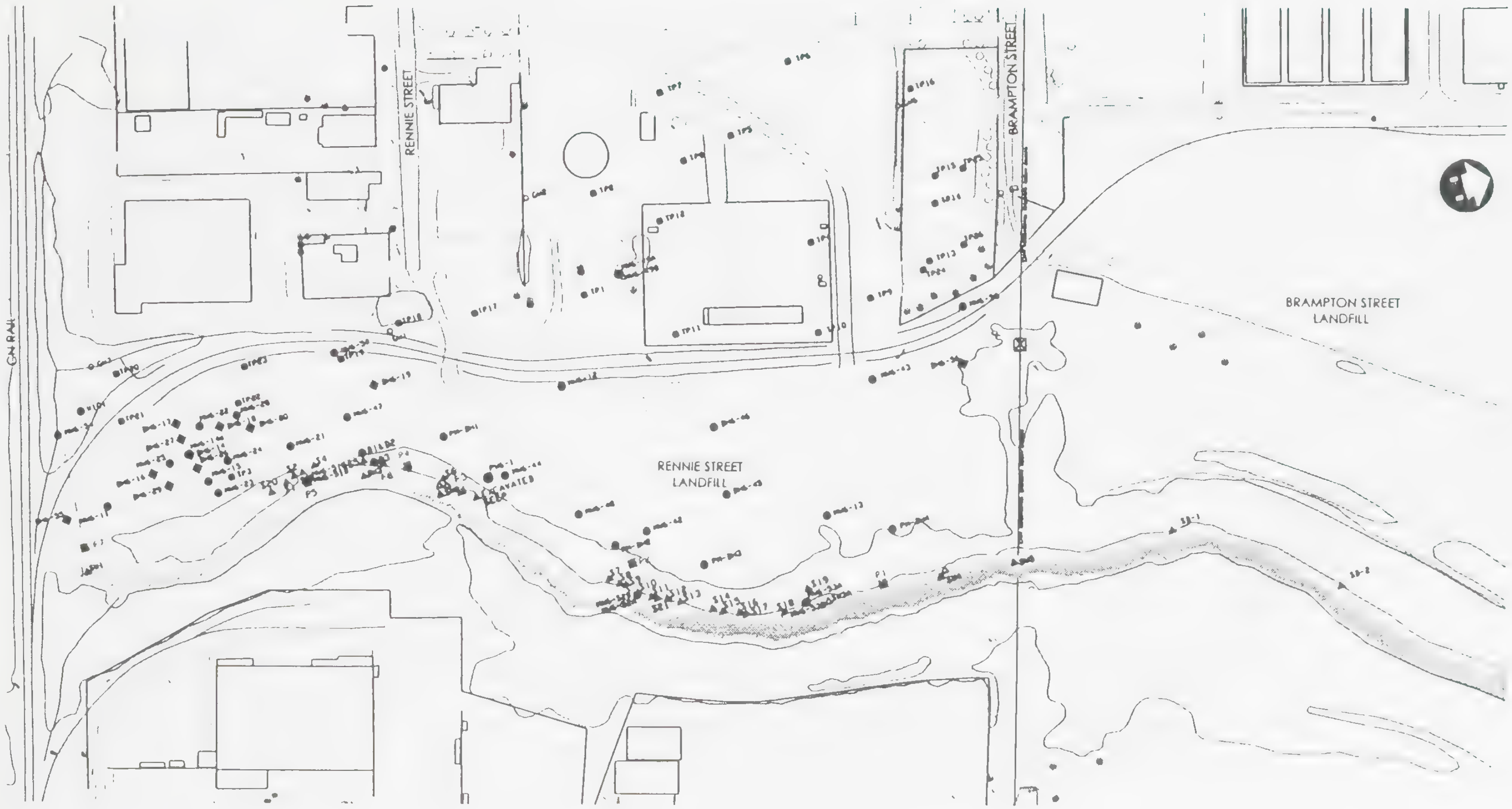
- The oily leachate has contaminated the soil on the west bank of Red Hill Creek.

- Erosion is causing oily seeps to be exposed at the Brampton Street Landfill.

- In the long-term, erosion and scouring of the bank is expected to eventually cause waste and contaminated soil to enter the creek.

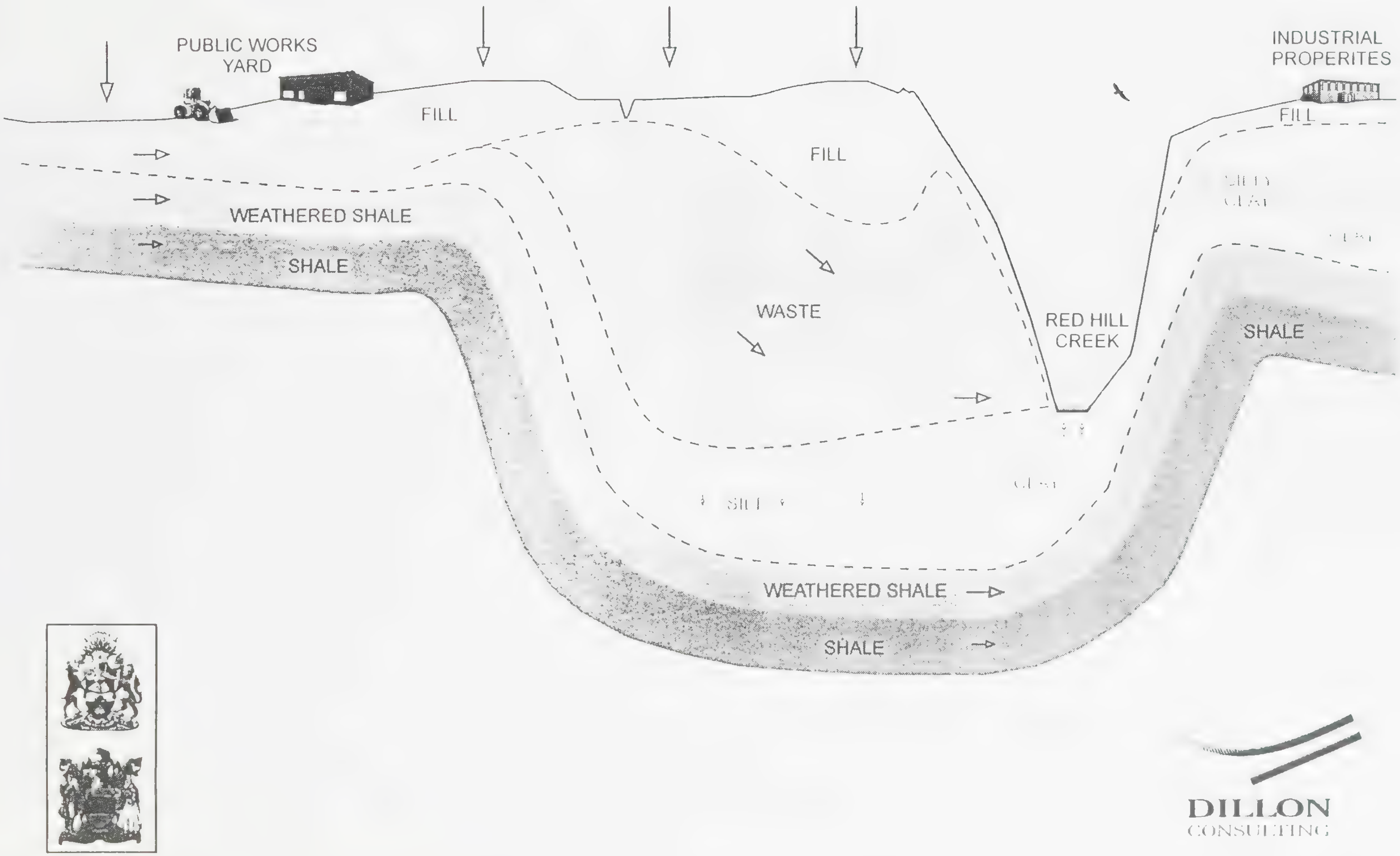
- The Rennie Street Landfill is generating landfill gas which should be vented to prevent movement off-site in the future.

SITE PLAN



DILLON
CONSULTING

LANDFILL CROSS-SECTION



ALTERNATIVE WAYS TO MANAGE THE PROBLEM

ALTERNATIVE	DESCRIPTION	APPROVALS REQUIRED	CONSTRUCTION DURATION	CONSTRUCTION DIFFICULTY	EFFECTIVENESS	ENVIRONMENTAL EFFECTS	SOCIAL EFFECTS	ADDRESSES EROSION	TREATMENT PLANT REQ'D	COST	COMMENT
Do Nothing	maintain status quo	none	N/A	N/A	not effective	continued environmental degradation	no change	no	no	$0	This alternative does not address any of the identified problems.
Remove Landfill	all of the waste in the landfill would be removed to a licensed facility	MOE	2 - 4 years	very difficult	likely	removal of creek west bank vegetation, replacement of entire site with vegetation	prolonged noise, odour and truck traffic during removal	yes	no	$26 million	This is the total removal of waste from the site it will produce severe and prolonged impacts to the neighbourhood and is extremely expensive
Purge Wells	leachate extraction wells installed along top of landfill to prevent leachate from reaching the bank	none	2 months	easy	further testing req'd	negligible	negligible	no	yes	$750,000 without treatment plant	Produces large volume of leachate for treatment, effectiveness unknown, test well results were not favourable
Trench West of Top of Slope	horizontal collector installed in waste to collect leachate before it reaches bank	none	3 - 6 months	very difficult	should be effective	negligible	some dust and odour during construction	no	yes	$2.81 million without treatment plant	Produces large volume of leachate for treatment, very difficult to construct because of depth
Retaining Wall at Creek	large concrete retaining wall along entire bank of creek, leachate collected in pipe behind wall	DFO/CA	6 - 12 months	extremely difficult	probably effective	complete destruction of fish habitat along west bank	some dust and odour during construction	yes	unknown	$9.85 million without treatment plant	Extremely large concrete structure that would isolate the landfill from the creek. Downstream impacts unknown
Regrade Slope	remove waste from slope of landfill and install collector at base adjacent creek	DFO/CA	3 - 6 months	moderate	likely	complete destruction of west bank of creek, mitigatable with replanting	some dust and odour during construction	not completely	unknown	$4.13 million without treatment plant	Requires movement of large volume of waste and re-piling on site

MOE - Ministry of the Environment *DFO - Department of Fisheries and Oceans* *CA - Conservation Authority* *N/A - Not Applicable*

ALTERNATIVE WAYS TO MANAGE THE PROBLEM (CONT'D)

ALTERNATIVE	DESCRIPTION	APPROVALS REQUIRED	CONSTRUCTION DURATION	CONSTRUCTION DIFFICULTY	EFFECTIVENESS	ENVIRONMENTAL EFFECTS	SOCIAL EFFECTS	ADDRESSES EROSION	TREATMENT PLANT REQ'D	COST	COMMENT
Relocate Creek	recreate natural floodplain to ensure long-term stability of creek, install leachate collector at base	DFO/CA	3 - 6 months	moderate	likely	net improvement in fish habitat, vegetation replanted	some dust and odour during construction	yes	unknown	$2.41 million without treatment plant	Provides separation of creek from landfill and creates area to install leachate collector
Install Cover on Landfill	install low-permeable cover on landfill to prevent water from entering the landfill and creating leachate	none	2 - 3 months	easy	likely	negligible	some dust and odour during construction	no	N/A	under development	Installing cap should help limit amount of leachate that is created
Install Perimeter Drain	a collector drain would be installed around west, north and south sides of landfill to collect groundwater before it enters the landfill	none	2 - 3 months	easy	likely	negligible	some dust and odour during construction	no	N/A	under development	Installing drain would further decrease amount of leachate being created. Testing required to ensure effectiveness
Remove Services Through Landfill	numerous sewer and water-main pipes cross the landfill, removing the pipes will eliminate leachate conduits	none	2 - 3 months	moderate	likely	negligible	some dust and odour during construction	no	N/A	under development	Removing obvious conduits will help eliminate leachate discharges
Install Localized Collector at Seeps	installing collector pipes in the bank at the seeps that drain to a holding tank to prevent seeps from reaching the creek	CA	1 - 2 months	moderate	likely	small areas of vegetation removed	negligible	no	no	under development	This alternative needs to be tested to determine effectiveness

MOE - Ministry of the Environment *DFO - Department of Fisheries and Oceans* *CA - Conservation Authority* *N/A - Not Applicable*

PROPOSED STRATEGY

Control leachate generation by placing a low-permeability cover on the landfill and collecting groundwater before it enters the landfill.

Collect leachate that seeps through the bank.

Prevent erosion by expanding the floodplain and relocating the creek away from the landfills.

FLOODPLAIN EXPANSION AND CREEK RELOCATION

- Widening the flooplain and relocating the creek will provide a stable, long-term, naturalized channel for the creek.

- The work necessary to do this will have environmental effects, however, these effects will be positive in the long-term.

- The following display boards describe the proposed work in the creek, the Environmental Assessment requirements, the results of a preliminary assessment of the environmental effects and potential mitigation measures.

ENVIRONMENTAL ASSESSEMENT

- Department of Fisheries and Oceans has indicated that approval under the Fisheries Act is required for the creek re-alignment and that the proposed creek works will require an Environmental Assessment (EA) under the *Canadian Environmental Assessment Act* (CEAA).

- The *Canadian Environmental Assessment Act* is a federally mandated Environmental Assessment process.

- An Environmental Assessment:
  - Is a planning and decision-making tool
  - Allows:
    - environmental effects to be identified and assessed
    - mitigation measures to be developed
    - significance of effects to be considered

TYPICAL CROSS-SECTION

WATER REGIME Investigations & Simulations Ltd.

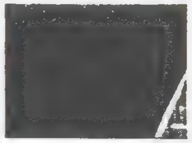
DILLON CONSULTING

AQUATIC HABITAT

1

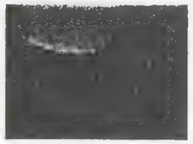
bank slumpage resulting in a silt load to the creek re establishment of the floodplain and the use of gentler slopes adjacent to the channel will rectify this condition in the re-located creek

2



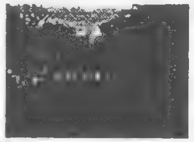
- gravel substrate in shallow riffle area provides spawning habitat for several fish species
- similar features will be incorporated into the re-located creek

3



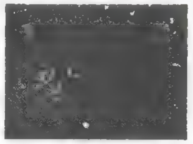
- no floodplain due to historical filling
- re establishment of the floodplain will lower peak flow velocity in the re-located creek and will facilitate habitat use by aquatic organisms

4



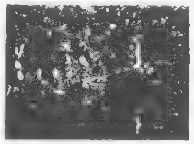
- deep pool at the base of a stream riffle provides good fish habitat
- similar features will be incorporated into the re located creek

5



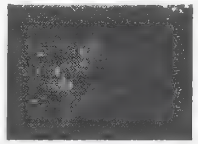
- gravel substrate in shallow riffle area provides spawning habitat for several fish species
- similar features will be incorporated into the re located creek

6



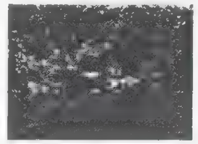
- bank failure resulting in a silt load to the creek
- re-establishment of the floodplain and the use of gentler slopes adjacent to the channel will rectify this condition in the re located creek

7



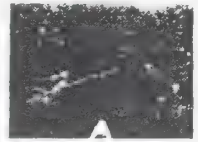
- isolated patches of large boulders provide resting and hiding places for fish
- similar features will be incorporated into the re located creek

8



- leachate discharging into Red Hill Creek
- moving the creek approximately 15-20 m to the east, and the proposed actions will rectify this situation

9



- large wood debris provides resting and hiding places for fish
- features that provide resting and hiding places will be incorporated into the re located creek

Legend

Rock vein

Cross vein

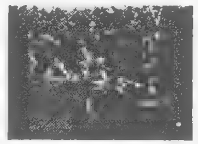
Limits of bankfull floodplain for proposed creek location

Limits of bankfull channel for proposed creek location

Centre line for proposed creek location

Existing creek

11



- large wood debris provides resting and hiding places for fish
- similar features will be incorporated into the re located creek

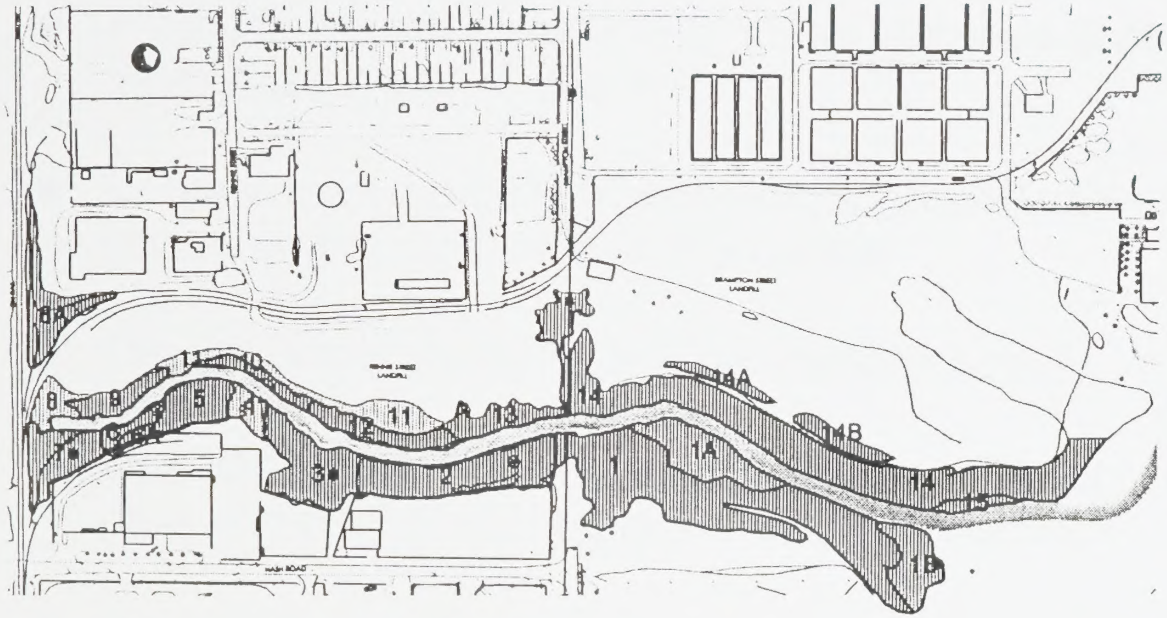
10

- deep (approximately 2 m) habitat exists from this point downstream to the Red Hill Marsh
- this condition will be replicated in the re located creek

ENVIRONMENTAL EFFECTS AND MITIGATION OPPORTUNITIES

ENVIRONMENTAL COMPONENT	DESCRIPTION OF POTENTIAL ADVERSE ENVIRONMENTAL EFFECTS	MITIGATION/COMPENSATION MEASURES
Fish/Fish Habitat	• loss of fish habitat in existing channel due to filling • sedimentation during construction • interruption of critical life history stages	• re-establish fish habitat, replicating the desirable habitat components that occur in the existing creek • enhance habitat where feasible and appropriate • erosion control measures such as silt curtain • timing of works to take place outside of the critical life history phases of resident fish species
Wildlife/Wildlife Habitat (Including Birds)	• loss of wildlife habitat • temporary disruption of habitat corridor	• re-creation of natural vegetation communities and wildlife habitat along new channel • re-connection of isolated habitat fragments through re-creation of natural vegetation communities and wildlife habitat along new channel
Endangered Species	• endangered species not present	• none required
Vegetation Resources	• loss of vegetation communities • removal of remnant old growth trees • loss of habitat for significant plant species	• re-establishment of vegetation cover on re-graded areas • establish planting and vegetation management programs • transplant significant species to suitable sites
Soils	• potentially contaminated soils may be encountered during realignment of creek	• on-site supervision and soil testing to identify impacted soils • soils will be managed consistent with regulatory requirements
Surface Water	• proposed floodplain widening may result in upstream and/or downstream erosion (further study required)	• erosion protection measures
Groundwater	• minor changes to groundwater flow patterns	• effects considered minor, therefore, no mitigation provided
Air Quality	• isolated dust during construction from on-site heavy equipment movement	• implement appropriate dust control measures
Noise	• noise during construction	• adhere to requirements of local noise bylaws
Social	• disruption of recreational use of trails along creek during construction	• disruption will be temporary, therefore, no mitigation provided
Archaeology/Heritage	• loss of potential or known archaeological sites in associated work areas during construction • loss of potential or known archaeological sites due to creek realignment • displacement or disruption of built heritage features and cultural heritage landscapes in associated work areas during construction • displacement or disruption of built heritage features and cultural heritage landscapes due to creek realignment	• assessment of all potentially affected lands with archaeological potential prior to construction • excavation of significant archaeological sites prior to construction or monitoring of significant archaeological sites during construction • identification and assessment of built heritage features and cultural heritage landscapes • recording or documenting built heritage features and cultural heritage landscapes to be displaced • protecting built heritage features and cultural heritage landscape during construction • post-construction landscaping measures to ensure continued protection or interpretation

TERRESTRIAL HABITAT



LEGEND

- Valley Slope Deciduous Forest
- Floodplain Deciduous Forest
- Open Meadow
- Open Meadow with Scattered Trees
- Open Bluff
- Shrub Thicket
- Riparian Marsh
- ⊛ Significant Plant Species
- * Heritage Trees

Dougan &
Associates
Ecological Consulting Services

IMPLEMENTATION PLAN

Task	Schedule
Construct a collection trench into the west bank of the creek:	
• Into seeps S1 - S4 at the south end of the site	June 2000
• Into seeps S7 - S19 at the north end of the site	July 2000
Evaluate the effectiveness of these trenches and extend to other seep areas if effective.	June - September 2000
Confirm the feasibility of installing a groundwater cut-off trench on the west side of the landfill.	June - July 2000
Design and construct a low-permeability cover.	June - December 2000
Re-locate buried utilities through Rennie Street Landfill and plug and cut off existing pipes where possible.	June - September 2000
If feasible, install temporary erosion protection in creek.	June - September 2000
Install passive gas barrier.	November 2000
Expand floodplain and relocate the creek:	
• Complete the design and Environmental Assessment	June - December 2000
• Construction	Contingent Upon Approvals